Devoted to
TEXTILE
CHEMISTRY
BLEACHING
DYEING
PRINTING
FINISHING

MARCH 10, 1947
VOLUME 36, No. 5

AMERICAN DYESTUFF REPORTER

MAR 29
GREENVILLE TEXTILE LIBRARY

Unchanging light fastness . . .

is assured with *Diphenyl Orange 4 G Conc.* in those cases where Urea Formaldehyde or Melamine finishes are employed.

One of a limited group of colors possessing this virtue *Diphenyl Orange 4 G Conc.* can be said to offer only slightly inferior light fastness to that of the outstanding Solophenyl colors.

Add to these properties those of commendable wash and water fastness on Rayon and Cotton and the ability to dye cotton-wool unions and *Diphenyl Orange 4 G Conc.* admittedly becomes a useful color to have around.

Acquaintanceship samples will be mailed promptly.

GEIGY COMPANY, INC.
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Geigy
Dyestuff Makers Since 1859
In Great Britain
The Geigy Co., Ltd.
National Buildings
Parsonage, Manchester

OFFICIAL PUBLICATION
of the
PROCEEDINGS
AMERICAN ASSOCIATION
OF TEXTILE CHEMISTS
AND COLORISTS

MEET YOUR NEEDS FOR SUPERIOR SMOOTHNESS AND SUPPLENESS *with...*

DECERESOL 1861 SOFTENER

1. SUPERIOR SMOOTHNESS and suppleness of hand in woolens, cottons, rayons and other specialties. Softening qualities retained after laundering and dry cleaning.

2. REDUCED BLEEDING of direct colors... *cracking* of naphthol colors. Minimizes gas-fading of certain acetate colors.

3. HIGH COMPATABILITY with gums, starches, solvents, acids and dilute alkalies (less than 1% NaOH).

4. SATISFACTORY REACTIONS with sulphonated oils and casein solutions, when used in proper ratios.

5. GOOD DISPERSION AND STABLE SUSPENSION... eliminates need for additional wetting agents in most instances.

DECERESOL* 1861 Softener . . . a durable, exceptionally compatible, odorless, surface active colloidal material . . . "engineered" to meet the demands of modern high speed textile processing. Excellent for yarns and fabrics; also for knitgoods where retention of elasticity is desired.

Be sure to send for Technical Bulletin giving general properties and full applications details.

★

AMONG CYANAMID PRODUCTS FOR THE TEXTILE INDUSTRY ARE . . . Penetrants, Softeners, Finishes, Sizing Compounds, DECERESOL* Wetting Agents, PARAMUL** 115 Water Repellent, and other Specialties and Heavy Chemicals

*Reg. U. S. Pat. Off. **Trade-mark

AMERICAN CYANAMID COMPANY PRODUCTS

Industrial Chemicals Division

AMERICAN CYANAMID COMPANY

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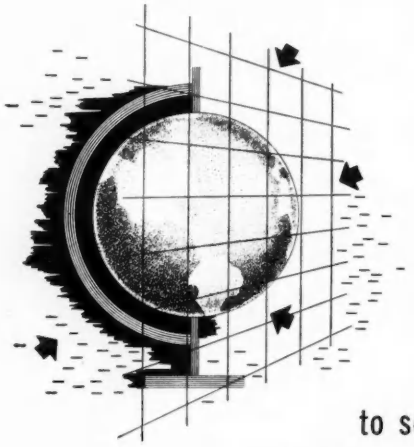

Spin the Globe...

There's a FALLEK Representative Everywhere!

Here is your opportunity to secure World Wide Distribution for American Dyestuffs ...

READ THESE FIGURES!

92% of the world's total exports in Coal-Tar Colors, Dyes and Stains were supplied by Europe to the rest of the world.*

4.6% of the world's total exports in Coal-Tar Colors, Dyes, and Stains were supplied by the United States to the rest of the world.*

With foreign production at a minimum level, now is the opportune time for American Suppliers to secure a solid foothold in the most lucrative overseas markets . . . and here is how FALLEK can help you:

FALLEK . . . eliminates costly credit risks. *You receive your check when your goods are ready for shipment* . . . as simple as a domestic transaction, but larger profits.

FALLEK . . . creates an acceptance for your products throughout world markets that assures continuous business.

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FALLEK . . . means permanence, through long established outlets in Europe, Latin America, and the Orient.

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FALLEK . . . brings you men of wide experience, men highly skilled in the problems of world distribution . . . plus skilled technicians in every foreign office fully equipped to render all the technical information necessary to users of American Dyestuffs.

American dyestuffs for textiles, leather, paper, etc., are in urgent demand throughout the world. You can realize a sizeable share of this business by making FALLEK your foreign selling agents. THIS is the time to safeguard profits against the hazards of "buyer's market" or a falling off in domestic demand, by developing a substantial export volume. FALLEK can do this for you.

**U. S. Tariff Commission Report No. 19 last pre-war figures*

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SPECIALISTS IN ORGANIC CHEMICALS

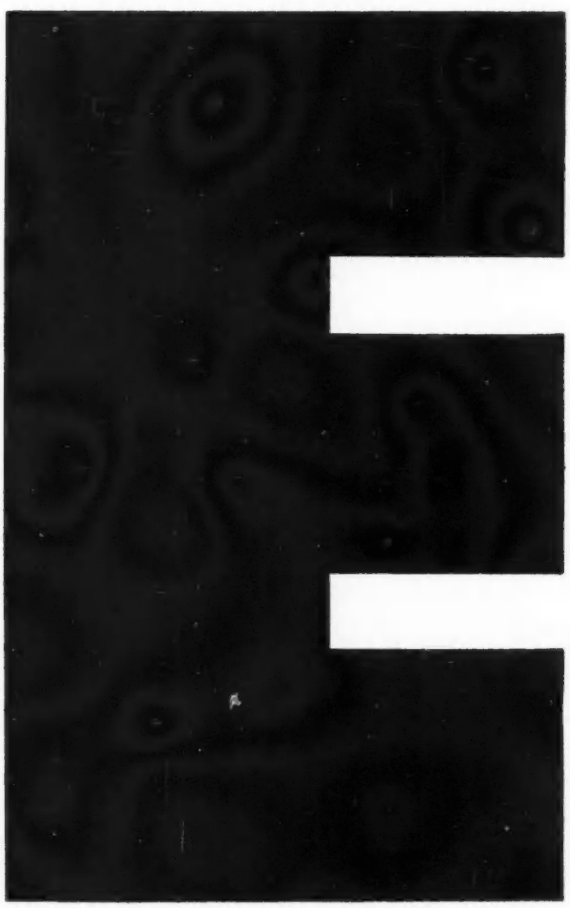
EASTMAN FAST VIOLET 5RLF

For Light-Fast Dyeing of Acetate Rayon and Nylon

EASTMAN FAST VIOLET 5RLF, an anthraquinone dyestuff, is one in a line of colors which have been developed with exceptional fastness to sunlight. On acetate rayon, this dyestuff produces a bright, clear red violet; pastel shades have twenty-five to forty hour light-fastness. It dyes nylon a somewhat bluer shade, and is one of the best acetate dyes for producing light-fast shades on nylon.

Eastman Fast Violet 5RLF dyes at temperatures ranging from 160°F to 190°F. It exhausts rapidly and levels well, and it is recommended for either jig or box dyeing.

The LF series to which this dye belongs is part of a wide variety of Eastman Acetate Dyestuffs for the dyeing of cellulose acetate rayon fibers and the fabrics in which they are used. Additional information on their application can be obtained by writing to TENNESSEE EASTMAN CORPORATION (Subsidiary of Eastman Kodak Company), KINGSPORT, TENNESSEE.



Eastman

ACETATE DYESTUFFS

JUST TURN A VALVE to "PASS the SALT" ANYWHERE IN YOUR PLANT

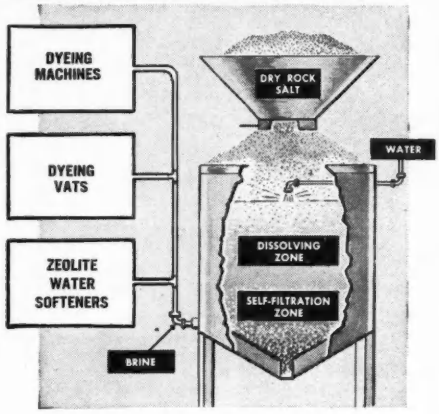
Put an end to SALT HANDLING with The LIXATE PROCESS for making brine

Weigh these production savings:

- **Eliminates shoveling salt from storage**
- **Ends hauling salt around the plant**
- **Saves time wasted in making brine**
- **Stops waste of salt by spilling**
- **Assures accurate salt measurement**

ECONOMICAL LIXATE BRINE made from Sterling Rock Salt has brought users savings as high as 20%. Completely automatic, the Lixator can be placed right at salt delivery or storage point. It supplies 100% saturated, free-flowing, crystal-clear brine by common steel piping to as many points in your plant as you wish . . . over any distance . . . by gravity flow or conventional pump and piping equipment. You simply turn a valve for pure, self-filtered brine that meets the most exacting chemical and bacterial standards for every salt need. It will pay you to investigate the Lixate Process for your plant.

HOW THE LIXATOR WORKS



In the upper zone—Flowing through a bed of rock salt which is continuously replenished by gravity feed, water dissolves salt to form 100% saturated brine. **In the lower zone**—Through use of the self-filtration principle *originated by International*, the saturated brine is thoroughly filtered through a bed of undissolved rock salt. The rock salt itself filters the brine. Nothing else is needed.

WHAT THE LIXATOR PROVIDES

- ✔ **Chemical and bacterial purity to meet the most exacting standards for brine**
- ✔ **Unvarying salt content of 2.65 pounds per gallon of brine**
- ✔ **Crystal-clear brine**
- ✔ **Continuous supply of brine**
- ✔ **Automatic salt and water feed to Lixator**
- ✔ **Inexpensive, rapid distribution of brine to points of use by pump and piping**

Completely flexible, a Lixate installation can be made to supply any needed brine requirement. No costly investment is required. The Lixator pays for itself out of savings. See how others have saved—write now for your copy of "The Lixate Process for Making Brine."

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City ..... *State* .....

The LIXATE *Process*

Reg. U. S. Pat. Off.

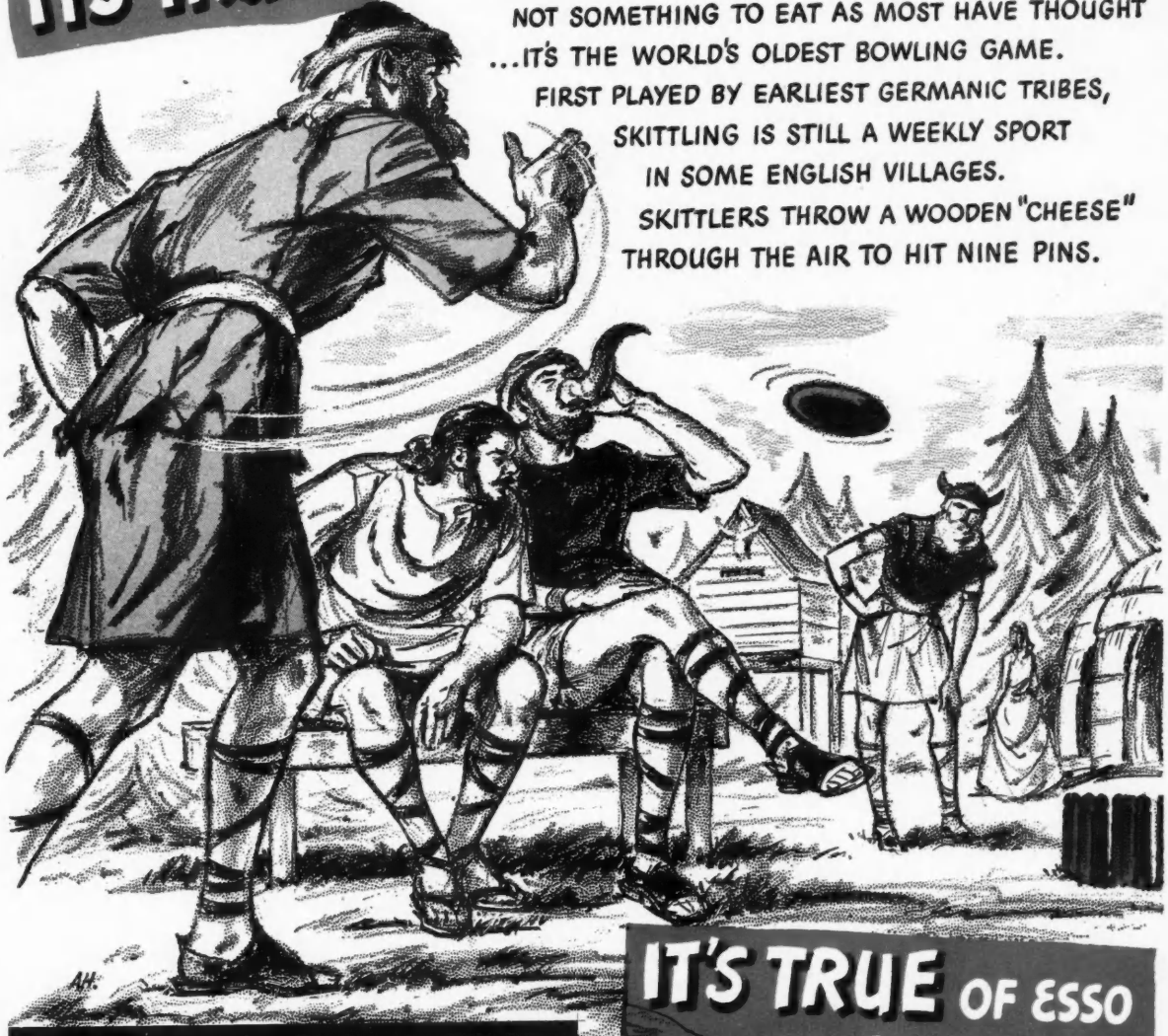
for making brine

INTERNATIONAL SALT COMPANY, INC.

Scranton, Pa.

IT'S TRUE...

"LIFE IS NOT ALL BEER AND SKITTLES," FOLKS HAVE SAID FOR HUNDREDS OF YEARS. BUT "SKITTLES" IS NOT SOMETHING TO EAT AS MOST HAVE THOUGHT ...IT'S THE WORLD'S OLDEST BOWLING GAME. FIRST PLAYED BY EARLIEST GERMANIC TRIBES, SKITTLING IS STILL A WEEKLY SPORT IN SOME ENGLISH VILLAGES. SKITTLERS THROW A WOODEN "CHEESE" THROUGH THE AIR TO HIT NINE PINS.



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STANDARD OIL COMPANY OF PENNSYLVANIA
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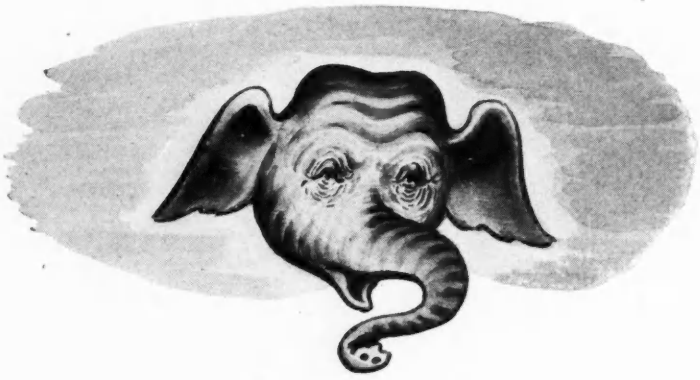
IT'S TRUE OF ESSO SOLVENTS

DURING THE LAST YEAR, TOTAL ESSO PETROLEUM SOLVENTS SALES WERE ENOUGH TO FULLY LOAD A TANK CAR TRAIN 71½ MILES LONG!

Hundreds of industries look to Esso Marketers for constant uniformity and suitability of solvents . . . and for friendly, dependable advice. Esso welcomes opportunities to assist with industrial solvents problems.



Remember when things were tight?

Remember when you called Hardesty and they made prompt delivery on Fatty Acids? Remember when Hardesty technicians supplied the answers to the problems created by the shortage of imported raw materials?

Fats and oils are still tight but Hardesty continues to offer the service and quality that has paid off for you in the past. The high quality of every Hardesty shipment is a direct outgrowth of Hardesty's never-ending research. Our fund of technical knowledge and experience, plus greatly expanded facilities are ready to go to work for you.

That is why we say it will continue to pay you to keep in touch with Hardesty now that fats and oils are off allocation and getting back to normal.

W. C. HARDESTY COMPANY, 41 East 42nd Street, New York 17, N. Y. FACTORIES: Dover, Ohio — Los Angeles, California — Toronto, Canada.

HARDESTY PRODUCTS: Stearic Acid — Red Oil — Glycerine — Stearine Pitch — White Oleine — Hydrogenated Fatty Acids — Animal and Vegetable Distilled Fatty Acids.

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COMPANY

Emulsion Chemicals for

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- cosmetics
- floor waxes
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- leather finishes
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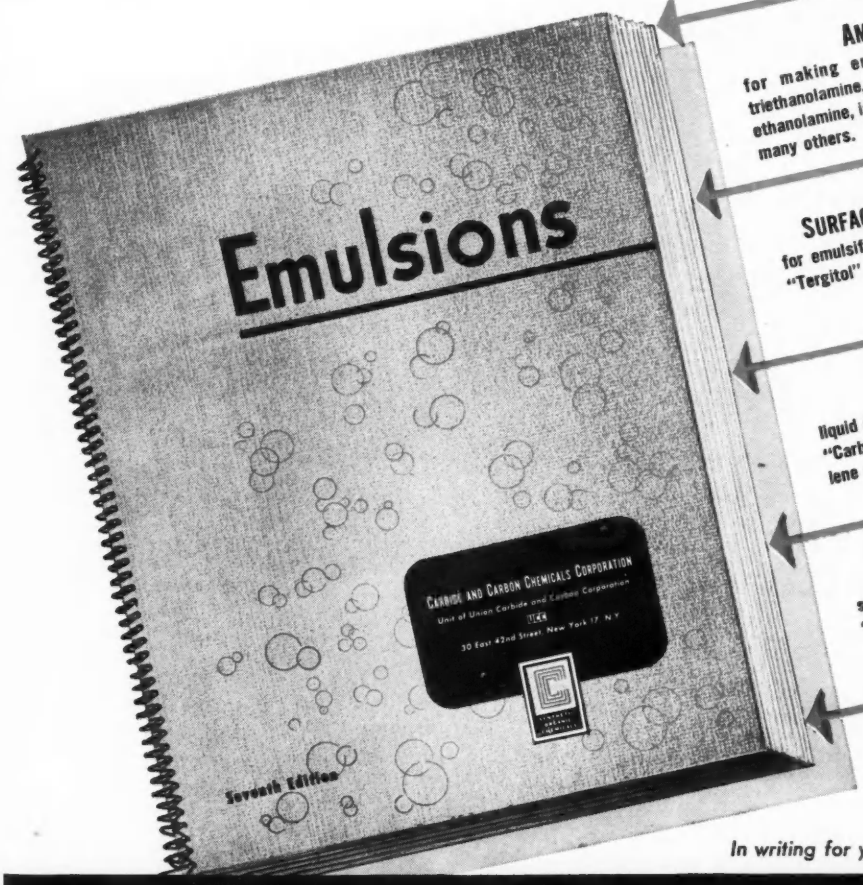
The seventh edition of our "Emulsions" book, containing suggested formulas and methods of emulsifying industrial oils, fats, waxes, and greases, has just been printed. This 72-page book includes complete information on the use of our chemical products in recently developed emulsion formulas: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Carbide and Carbon Chemicals Corporation
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for making emulsifying agents: triethanolamine, morpholine, monoethanolamine, isopropanolamines, and many others.

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Aluminum Chloride—As You Like It

Consistently uniform high purity is one reason why processors like to use Hooker Aluminum Chloride, Anhydrous. They know that here is one catalyst that will not "gum up" the works because of unknown impurities or changes in analysis from one shipment to another. Where smooth operations depend upon uniform purity of the Aluminum Chloride, you can depend on Hooker.

In Hooker Aluminum Chloride, too, you have a choice of three sizes from which you can select the one which will give you the best results.

Fine Grind .....an unscreened material practically all passing 20 mesh.

Coarse Grind ....unscreened, 1 mesh and finer containing 25 to 35% finer than 20 mesh.

Coarse Screened . .same as above screened to remove 20 mesh and finer.

Hooker Aluminum Chloride is being used as a catalyst in many Friedel-Crafts syntheses, polymerization, isomerization and halogenation. Practically free from iron (0.05% max.) it is especially desirable in the preparation of derivatives for use in the manufacture of high octane gasoline, lubricants, synthetic rubber, dyes, varnishes and pharmaceuticals.

Additional physical and chemical data on this important chemical are contained in Technical Data Sheet 714, sent when requested on your letterhead. Hooker's Technical Staff is also available for consultation and help on the application of Aluminum Chloride and the other Hooker chemicals to your purposes.

SPECIFICATIONS

Hooker Aluminum Chloride, Anhydrous $AlCl_3$
Gray, crystalline solid in three sizes.
Molecular Weight 133.3

ANALYSIS

Aluminum Chloride	98.5 % min.
Iron	0.05% max.
Non-sublimables in air at 950° C.	1.5 % max.

From the salt of the earth

HOOKER CHEMICALS

HOOKER ELECTROCHEMICAL COMPANY

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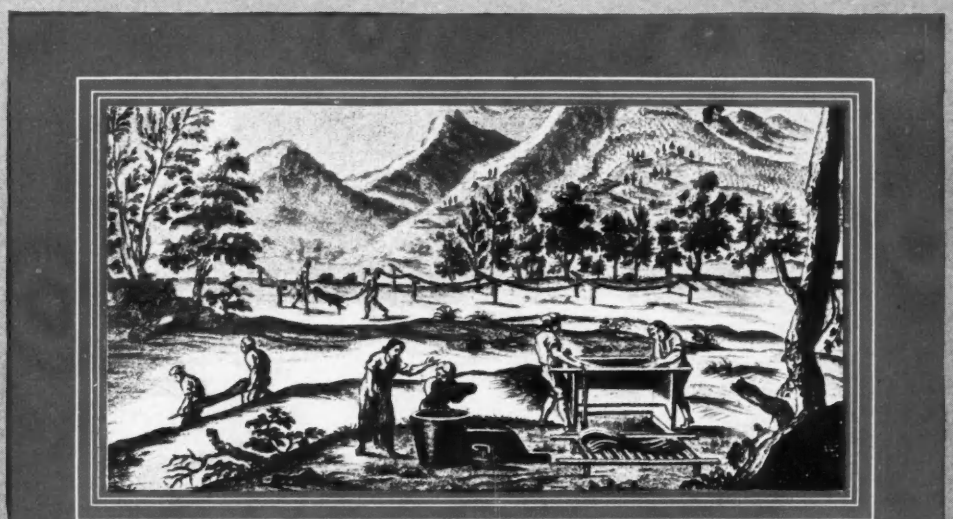
Caustic Soda **Paradichlorbenzene** **Muriatic Acid** **Chlorine** **Sodium Sulfide** **Sodium Sulfhydrate**



Early Sizing of Yarn—Believed to be circa 1805
The sizing was prepared by boiling in a kettle. Then the yarn was dipped in the sizing to coat it, and hung on racks to dry in the open.

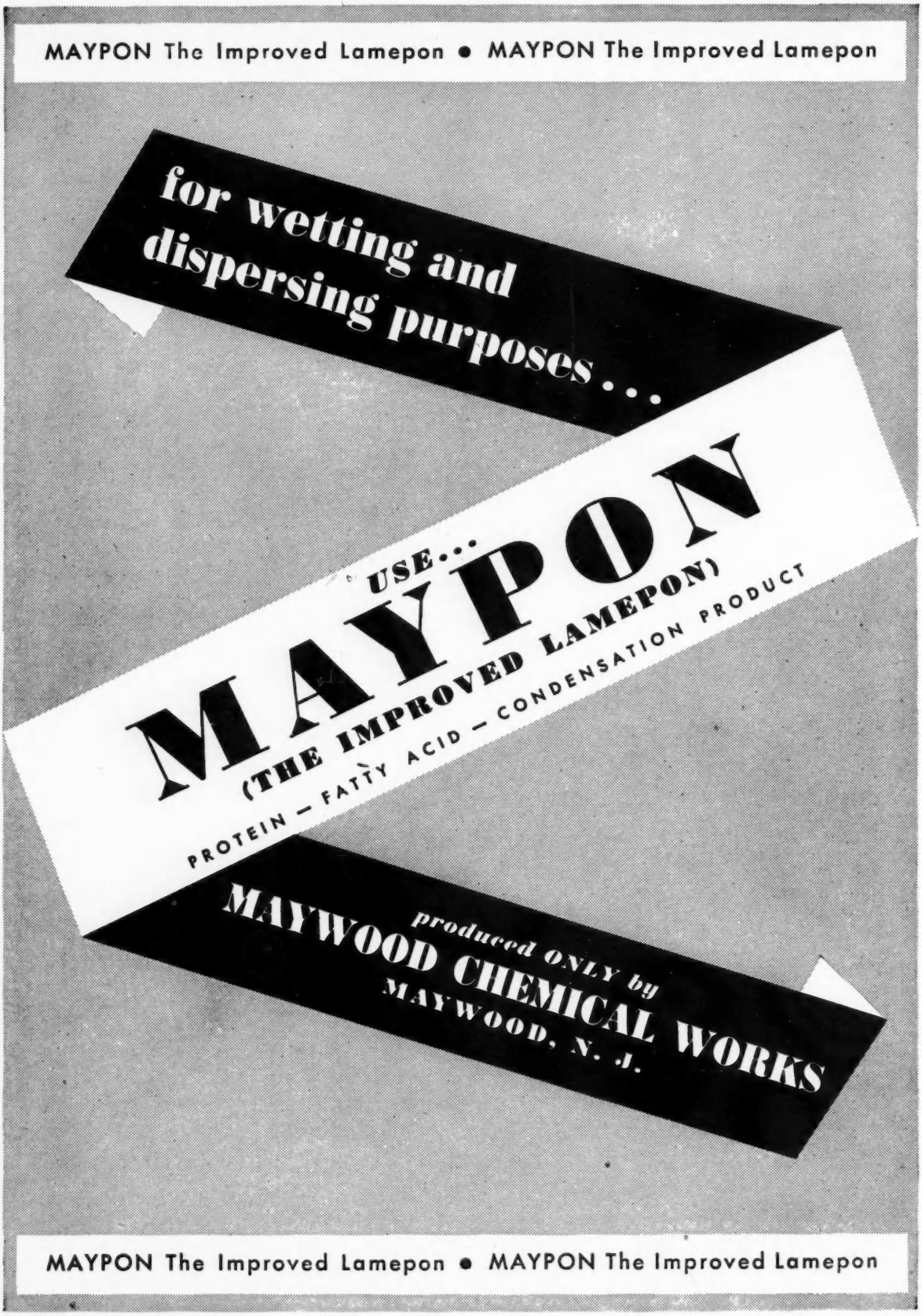
Why De-Size?

Sizing is added to the warp threads to strengthen and protect them during the weaving operation. Once it has served its purpose, the sizing must be rapidly and effectively removed so that it will neither delay dyeing, bleaching or finishing, nor impair the quality of the work.

Rapidase gives complete satisfaction in
de-sizing cottons, rayons and mixed goods.

RAPIDASE

WALLERSTEIN COMPANY, INC. 180 Madison Ave., New York 16, N. Y.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for wetting and dispersing purposes . . .
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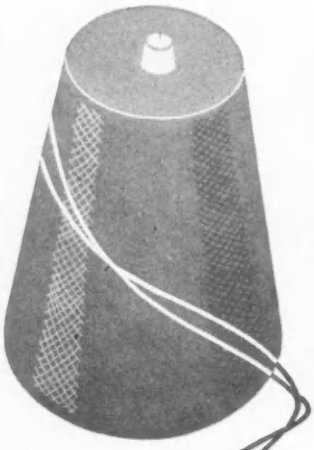

ANNOUNCEMENT... BY MONSANTO:

the first basic improvement in spinning chemicals in 40 years

The entire textile world, and particularly the spinners, are interested in the "ready-for-sale" announcement by Monsanto, of its new anti-lubricant for worsted spinning. This specially developed colloidal dispersion in water:

1 Reduces twist . . . without reducing strength of yarn	**2** Cuts spinning time, cuts spinning cost
3 Produces loftier yarn	**4** Produces more uniform yarn
5 Reduces ageing time after oiling	**6** Reduces ends down on spinning frame by 50% and better

This new process requires no new machinery, does not slow up any operation. You can have a demonstration in your plant of this new, proved product, or full technical data by writing: MONSANTO CHEMICAL COMPANY, 140 Federal Street, Boston 10, Massachusetts.

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CHEMICALS — PLASTICS
SERVING INDUSTRY WHICH SERVES MANKIND

An old friend

of the rayon industry returns

NOPCO* 1111

premier soaking oil and warp size softener

Back "in harness" for the first time since the beginning of the war, Nopco 1111 returns to assure rayon throwsters and weavers the same quality and uniformity which made it the standard in pre-war days.

*REG. U. S. PAT. OFF.

WRITE for data bulletins "Important Points Regarding Rayon Warp Sizing." "Nopco 1111 – Soaking Oil for Rayon Crepe Yarns."

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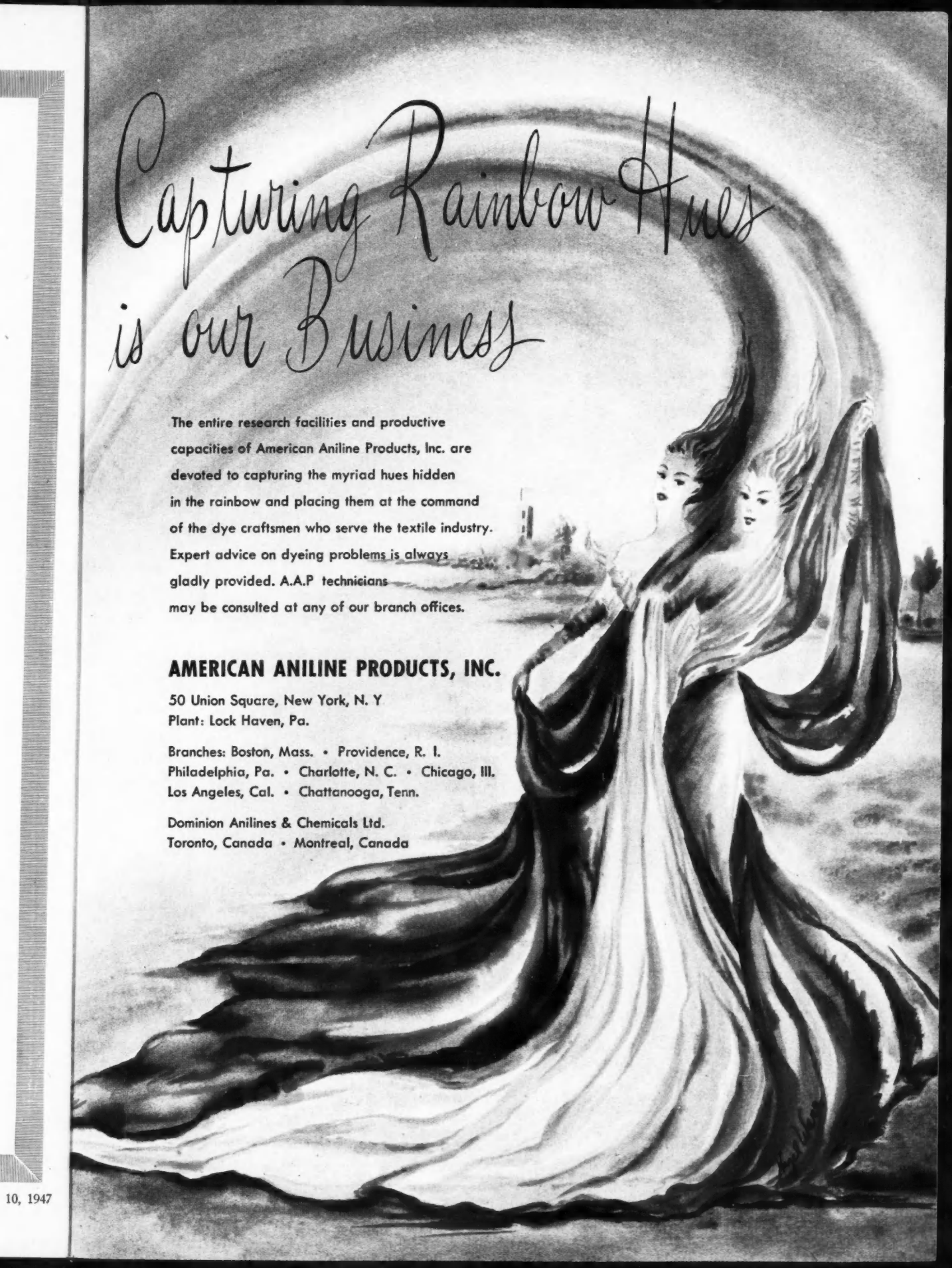
Branches: Boston • Chicago • Cedartown, Ga. • Richmond, Calif.

NOPCO

EVOLVED THROUGH RESEARCH


Capturing Rainbow Hues
is our Business
The entire research facilities and productive capacities of American Aniline Products, Inc. are devoted to capturing the myriad hues hidden in the rainbow and placing them at the command of the dye craftsmen who serve the textile industry. Expert advice on dyeing problems is always gladly provided. A.A.P technicians may be consulted at any of our branch offices.
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LOOK INTO THE "O" FILE FOR

2 Satisfying Answers

TO YOUR TEXTILE PROCESSING PROBLEMS

Soaps or synthetic cleaning agents? Which will be better suited to the type of materials you handle and to your particular operating conditions? Your own experience can best answer this question.

But whatever your preference may be, you'll get top performance from either Olate or Orvus in your wet finishing operations. And there's a good chance you'll find that both can be helpful in your mill.

Olate

A pure, neutral, low titer flake soap with a reputation of many years' standing as an efficient scouring and fulling agent.

Fast dissolving, fast rinsing.

Fluid solutions—wet out fibers quickly, evenly, thoroughly.

Excellent emulsifying and lubricating properties.

Gentle cleansing action.

Provides excellent protection against uneven shrinkage and non-uniform fulling . . . against harshness or stickiness.

Retains its efficiency at lower-than-average temperatures.

ORVUS*

A gardinol-type product (sulfated fatty alcohol).

Fast, thorough wetting, emulsifying and scouring action.

Effective even in hard water. Helps guard against scum, streaks, specks and spots from hard water deposits.

Effective in presence of acids and alkalis.

Safe to fiber, fabric and color. Excellent results in scouring fugitive colors.

Promotes more uniform and thorough dyeing.

Helps prevent undesirable odor and yellowing of goods in storage.

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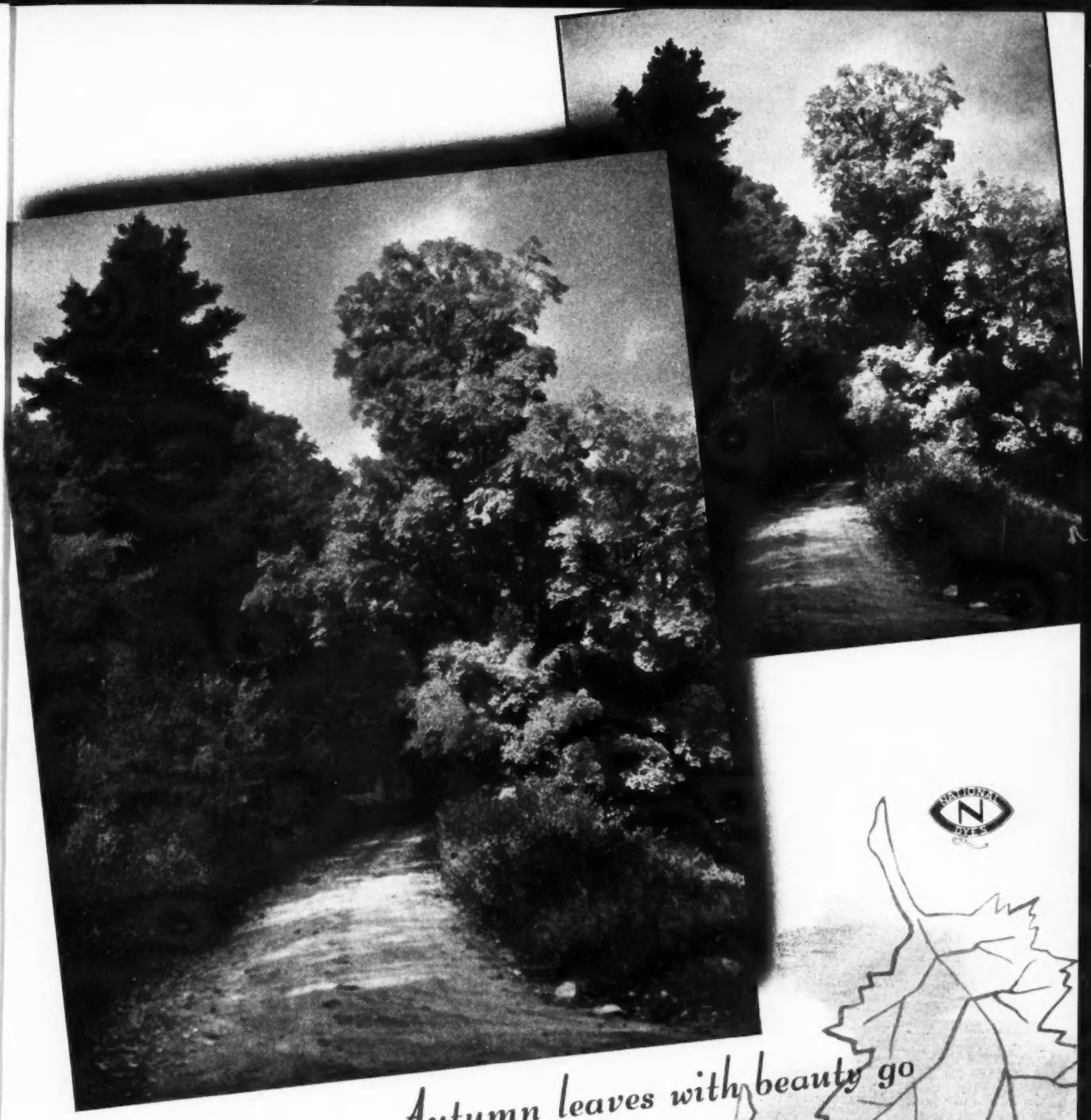
Procter & Gamble

*ORVUS is a Procter & Gamble trade-mark.



. . . Autumn leaves with beauty go

Without color, Autumn's pageant becomes just another landscape. Without color, textiles too would be dull lifeless goods. Add color . . . and they become dramatic merchandise . . . with endless profit possibilities.

National Aniline knows color . . . knows its formulation, manufacture and application . . . knows its effective use from the longest and broadest experience in every field where color is used.

For uniform and dependable results, always specify National Dyes.

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"there goes another one, Dad!"

Yes, you see them everywhere! Mathieson's tank cars really get around as they speed millions of gallons of dependable Mathieson chemicals to our hundreds of customers throughout the chemical-consuming industries.

Mathieson transportation equipment also includes super-insulated Mathieson Dry Ice cars . . . multi-unit Chlorine Gas tank cars holding 15 one-ton containers (a method of delivery originated by Mathieson) . . . drums, barrels, containers . . . Ammonia, Chlorine and Carbonic Gas cylinders.

Modern transportation equipment helps maintain Mathieson's reputation for making prompt deliveries of the best in chemicals. *The Mathieson Alkali Works (Inc.), 60 East 42nd Street, New York 17, N. Y.*

Mathieson
CHEMICALS

Caustic Soda . . . Soda Ash . . . Bicarbonate of Soda Liquid Chlorine . . Chlorine Dioxide . . . Ammonia, Anhydrous & Aqua . . . HTH Products . . . Fused Alkali Products . . . Synthetic Salt Cake . . . Dry Ice . . . Carbonic Gas . . . Sodium Chlorite Products . . Sodium Methylate

ONYX IONICS

Newsworthy Items for Textile Technologists and Production Men

Volume 1 | March, 1947 | Number 2

Onyxsan LG is particularly effective for imparting a smooth, silky hand to candlewick textiles.

A New Cationic Softener With Unusual Resistance to Washing

Those in search of a softening effect with considerably increased resistance to washing will find Onyxsan LG worth careful investigation.

The Onyxsans have been assuring softer finishes, better drape and lasting hand on all kinds of fabrics for many years. They have made it possible to get a needed finish on many textiles which would otherwise be harsh and rough and virtually impossible to improve by ordinary methods.

Now Onyxsan LG is added to the series. This new Onyxsan is marked by the unusual durability of its softening action and a truly noteworthy resistance to washing. It provides a characteristically smooth, drapable, silky hand.

Like other Onyxsans, it is easy to use in applications in the dye beck, pad, jig or quetsch, followed by normal drying. Its action is due to effective plasticizing, thorough penetration and surface orientation of the cation-active radical of its composition. Unlike ordinary superficial surface lubrication, the Onyxsan effect is based on softness produced IN the yarn itself. Strikingly small amounts of Onyxsan LG are required.

General Purpose Resin Finish Requires No Curing

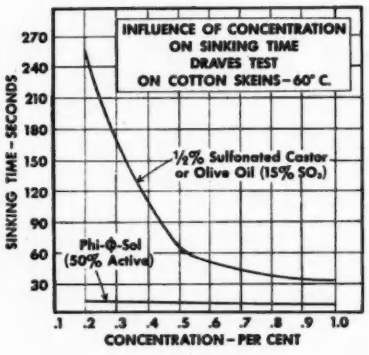
Developed as a general purpose finish for cotton, wool, acetate and rayon, Xyno Resin AA40 is a highly versatile material. It is readily manipulated to give either a full, mellow hand, or good stiffness and body without impairing luster.

It is a vinyl dispersion containing 40% resin of fine particle size. Its dilutions are very stable, and may be mixed with starch, gelatine, glue, water repellents, etc. It is free from solvents.

Xyno Resin AA40 requires no curing. Goods are handled in the normal manner.

Most Economical Wetting Agent

Phi-Φ-Sol WG is one of the most effective wetting agents known today, and in addition is the most economical in use because of its low first cost as well as its efficiency in very small dilutions. It can be used with all types of dyeing, bleaching and finishing agents with the one exception of cation-active materials, and is applicable to all textiles. Wherever fast wetting and penetration are required, Phi-Φ-Sol WG deserves investigation.



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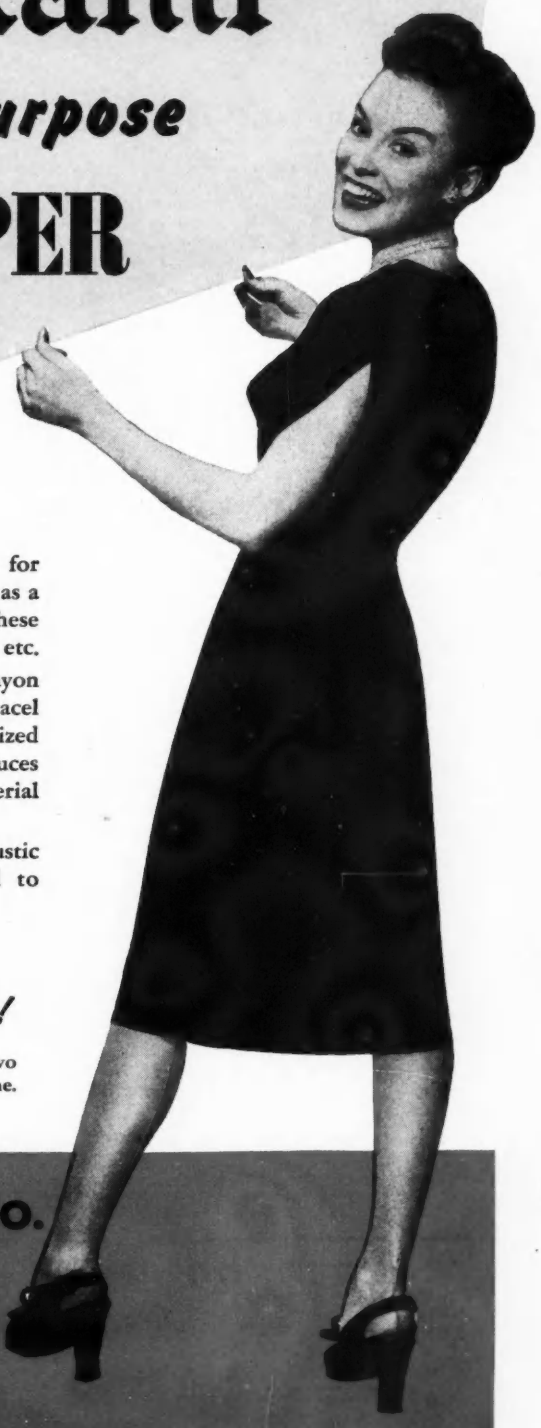

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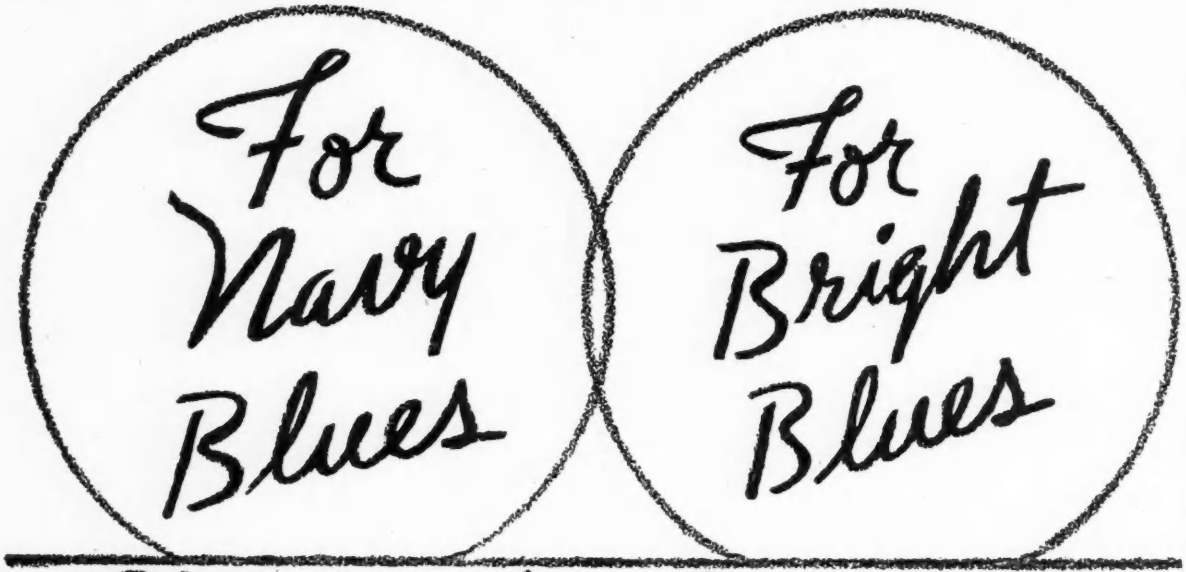

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MARCH 10, 1947

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Proceedings of the
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MARCH 10, 1947

Fire Resistance in Aircraft Textiles

JAMES R. REDMOND
Chairman, Committee on Testing Fire Resistant Materials

THE pilots of our commercial air lines have recently stated that fire is the hazard they fear the most. They look to the textile industry to do its part in reducing fire hazards in aircraft.

The AATCC Committee on Testing Fire Resistant Materials has been asked to aid the campaign of the air line operators who seek fire resistant textiles. This is not merely a problem of flash resistance. The Air Transport Association seeks textiles which are engineered or processed to actually resist flame. Tentative testing regulations of the Civil Aeronautics Administration include an exposure of the textile to a flame for fifteen seconds.

Allen W. Dallas, Director of Engineering Division, Air Transport Association of America, 1107 Sixteenth Street, N. W., Washington 6, D. C., is actively engaged in effecting the needed liaison between the air line operators and the manufacturers of fire resistant materials. Mr. Dallas calls attention to the C. A. A. Proposed Safety Regulation which is dated December 17, 1946, and represents the present thinking of the C. A. A. This Proposed Regulation was described a short time ago in the *Daily News Record*.

Flame resistant material is defined in the C. A. A. Regulation as material which will not support combustion to the point of propagating a flame, beyond safe limits, after removal of the ignition source.

Flash resistant material is defined as material which will not burn violently when ignited.

The C. A. A. test procedure for both flame-resistant materials and flash-resistant materials is as follows:

A specimen shall be clamped in a frame exposing an area 2″ x 12″ for test purposes. The length shall be in the warp direction or in the direction indicated as most hazardous by the pattern or tufting. The frame shall cover the edges of the specimen except at one end a space approximately ½″ shall be left for ignition purposes. A 10″ length of the specimen shall be suitably marked for timing purposes. Approximately 1½″ should burn before the spearhead of the ame enters the timing zone. The specimen shall be supported horizontally for the test, with sufficient space on all sides to provide adequate air for good combustion. Suitable precautions should be taken to avoid drafts. If a coated or napped fabric is used, the coating or nap shall be used on the lower surface. Ignition may be made with a match or any other means readily available.

To be declared flame-resistant, the material must show a rate of burning or flashing of not greater than 2.5 inches per minute. If the flame extinguishes itself, the glow should not extend into undamaged places.

To be declared flash-resistant, the material must show a rate of burning or flashing of not greater than 20 inches per minute.

Regardless of the category under which a fabric is being tested, if the specimen does not support combustion after the igniting flame is applied for 15 seconds, it is considered acceptable.

Materials which are considered satisfactory without further treatment or testing are: cellulose acetate butyrate doped fabrics, flame-resistant treated fabrics, mohair, wood, glass fibers, artificial leather complying with Navy Specification 34-L-13 or A. A. F. Specification No. 12026-A, and metal-faced sandwich construction. If fabrics treated to be flame resistant are used, they shall be retreated after each laundering or dry cleaning unless it can be demonstrated that the treatment is not affected by same. All fabrics shall be retested at periodic intervals of not greater than one year unless this can be proven to be unnecessary.

For further guidance in connection with flash-resistant materials, the CAA Release notes that many fabrics should qualify and particularly if they are of heavy, tightly woven materials. Untreated fabrics which are loosely woven or have a nap or tufting generally are dangerously inflammable and should not be used.

New aircraft are expected to comply completely with the regulations. On the other hand, the CAA indicates that existing aircraft should be inspected in the light of the intent of the regulations rather than a literal translation of each specific requirement. The basic objective of the regulations is safety and through this Release the CAA hopes to assist field personnel in interpreting the retroactive phases of these new requirements.

In a discussion of "Cabin Interiors," the CAA indicates that it must be determined whether or not the present doped fabric cabin lining is acceptable under the requirements set forth. With this in ciew, the following burn rates, in inches per minute, obtained from the National Bureau of Standards, may be helpful.

Cellulose acetate butyrate fabric	2.0″/min.
Cellulose acetate doped fabric	4.8″/min.
Cellulose nitrate doped fabric	23.2″/min.

The weights of the doped fabrics were approximately 5.9 ounces per square yard.

From the above data, it is believed that any fabric with a burn rate of approximately 5″ per minute would not present any excessive fire risk if permitted to remain until the cabin is normally relined. However, tests made by some of the airlines, of samples from the linings in their airplanes, show a burn rate of from 8″

(Concluded on Page P121)

Intersectional Contest—

How the Mineral Content of Cotton Can Affect Beam Dyeing with Vat Colors

Presented by

SOUTHEASTERN SECTION

COMMITTEE

Matthew T. Barnhill, *Chairman*
Robert O. Simmons
Henry L. Dozier
James C. Farrow
Norman P. Arnold
Speaker
Dr. Howard M. Waddle
Judge
Curt Mueller

Purpose

The primary purpose of this research is to demonstrate that the mineral content of some cotton is capable of producing uneven dyeings in its yarn when such yarn is dyed on dye beams with vat dyestuffs.

It is suggested that the mineral content may be a factor worth considering in dyeing cotton in other types of equipment.

Scope

The work in this paper has been limited to beam dyeing of single cotton warp yarns of numbers 26's to 40's.

General Background

Before outlining this research a word of explanation is necessary. The reader should know that beam dyeing is done with a rather inadequate rate of liquor flow. This is generally less than 2 gallons per pound of yarn per minute in contrast to package dyeing where rates of 3 to 4 gallons per pound of yarn per minute are common. The warp threads are wound on a dye beam side by side in a parallel manner to facilitate the slashing operation which generally follows the dyeing. Wound in this manner the threads easily split apart in dyeing causing the dye liquor to chanel unless the rate of flow is kept at a minimum.

Obviously, since the rate of flow in either beam or package dyeing is a major factor in producing level dyeings with the relatively rapid exhausting vat dyes, it is essential in beam dyeing that this rate be maintained at the maximum the yarn will withstand without channeling. Any condition which reduces or retards this rate of flow will tend to produce uneven dyeings.

A condition of this nature existed at the textile mill under consideration in this research. After dyeing, the outside and inside windings from the beams were invariably dyed a darker shade than the middle windings.

* Presented at Intersectional Contest, Silver Jubilee Convention, Hotel Statler, Boston, Mass., December 13, 1946.

Some Known Facts

(1) The cotton being dyed may be classed as a good character rain-grown cotton, 1-1/16" staple, and middling grade. Most of it was likely from Mississippi.

(2) All beams seemed to have a uniformly firm, but not too hard, winding. They were produced on a standard Barber-Colman dye beam warper.

(3) In dyeing, both cold and hot dyeing anthraquinone vat colors were being used.

(4) The variation in the depth of shade from beginning to end in the dyed beams was sometimes as much as 10% or more.

(5) In each individual dyeing there was a noticeable deposit of some insoluble matter on both the outside and inside winding. The shade was always dull and somewhat lifeless from these windings but between these two extremes the dyeings were quite clear.

(6) This deposit persisted despite changes in dyeing procedures. These changes included various combinations of several penetrants, detergents, retarding agents, and recommended phosphate materials. It is worth mentioning that trials had also been made in dyeing these beams without the use of any of these agents, but with equally poor results.

Procedure

We begin this research with a situation that is producing uneven dyeings on beams. All procedure seeks to determine and to prove the cause.

A Study of the Water Supply

The source of the water used in dyeing was a creek. The water was clear enough to be used without first filtering, but it was necessary to soften it previous to the dyeing operation. Permutit softeners were employed for this purpose and an analysis of the fully treated water is given in the following table.

ANALYSIS OF FULLY TREATED WATER FROM CREEK

	Parts per Million
Silica	9.2
Iron	0.4
Aluminum	0.8
Calcium	3.8
Magnesium	1.7
Sodium	68.7
Potassium	0.8
Carbonate	0.0
Bicarbonate	157.5
Sulphate	19.8
Chloride	15.3
Phosphate	Trace

Analysis by Picard Testing Laboratories, Inc. April 30, 1946.

The preceding analysis did not indicate anything that might be detrimental to vat dyeing. Nevertheless, something was causing the dyeings to be consistently unsatisfactory.

The analysis of creek water might vary from day to day. Accordingly, it was decided to change the source of water to the city water mains where the analysis was known to vary but slightly the year round. This water was clear and very pure, an analysis of which is given here.

ANALYSIS OF CITY WATER BEFORE ZEOLITE TREATMENT

	Parts per Million
Silica	3.5
Iron	0.1
Aluminum	1.1
Manganese	None
Calcium	18.3
Magnesium	5.0
Sodium	7.2
Potassium	9.1
Carbonate	9.0
Bicarbonate	42.7
Sulphate	38.4
Chloride	5.4
Nitrate	0.2

ANALYSIS OF CITY WATER—(*Continued*)

	Parts per Million
Phosphate	None
Free CO_2	None
Hardness (Ca.Mg.)	66.3
Hardness (Total)	72.6
Total Dissolved Matter	140.5
Organic Matter	0.5
Mineral Matter pH 7.7	140.0

Analysis by Picard Testing Laboratories, Inc. June 20, 1946.

Before use in the dye house, the above water was treated in a Permutit softener. Indications were that the resulting soft water was well within the safe limits of hardness for satisfactory vat dyeing. However, after two weeks continuous use of this water, the dyeings showed no improvement.

From this experience it appeared that the water being used was not the cause of the uneven and dull dyeings. However, in order to verify this opinion, it was decided to take a beam filled with yarn to another locality where trouble of a similar nature was not occurring, and have it dyed.

This procedure produced a beam that was unevenly dyed. The outside and inside windings showed the same dingy deposit that had been present on all vat dyeings made at the first mill.

The only difference of any consequence in these two mills seemed to be in the actual cotton being used. Both plants employed the same type beam dyeing equipment, the vat dyestuffs were being obtained from the same source, and Permutit water softeners prepared the water used for dyeing.

The mill having no apparent trouble from uneven dyeings was using a good character rain-grown cotton, 1" staple, and middling grade. As previously stated, the cotton being dyed in the dye house experiencing the trouble, was classed as good character rain-grown middling grade cotton of 1-1/16" staple.

It was deemed advisable to compare the mineral content of the two cottons. The ash analysis of each is given in the following table.

TABLE SHOWING ASH ANALYSIS OF TWO UNDYED COTTONS PREVIOUS TO ANY TREATMENT OR WETOUT

	1" Staple	*1-1/16" Staple*
Extraction matter (Fats, waxes)	0.39%	0.40%
Total ash	1.13%	1.01%
Silica	0.01%	0.01%
Iron	0.01%	0.01%
Aluminum	0.01%	0.02%
Manganese	Trace	0.00%
Calcium	0.04%	0.04%
Magnesium	0.05%	0.06%
Sodium	0.15%	0.02%
Potassium	0.27%	0.26%
Carbonate	0.21%	0.25%
Bicarbonate	0.08%	0.00%
Sulphate	0.04%	0.10%
Chloride	0.05%	0.16%
Phosphate	0.21%	0.08%

Picard Testing Laboratories, Inc. Analyses of April 30, 1946 and September 5, 1946.

In the 1" Staple cotton above, the ash is essentially Calcium and Magnesium in the form of water insoluble phosphate, with a small amount of Sulphate, and Sodium and Potassium in water soluble form as Carbonates, Bicarbonates, Sulphates, Chlorides and Phosphates.

A Study of the Actual Dyed Yarn

A typical dyed beam was selected having about the average amount of deposit on the outer windings. The shade was a pastel lime color largely made from Flavone GC.

A sample of yarn from the outer winding was taken and an ash analysis was made. A comparison of this and the original natural yarn is given in this table.

ASH ANALYSIS OF DYED YARN VERSUS NATURAL RAW YARN

	(1-1/16" Staple Cotton) Raw Yarn	*Outer Windings From Dyed Yarn*
Total Ash	1.01%	3.17%
Silica	0.01%	0.05%
Iron	0.01%	0.02%
Aluminum	0.02%	0.06%
Calcium	0.04%	0.23%
Magnesium	0.06%	0.70%
Sodium	0.02%	0.15%
Potassium	0.26%	0.06%
Carbonate	0.25%	0.15%
Sulphate	0.10%	0.24%
Chloride	0.16%	0.12%
Phosphate	0.08%	0.42%
Hydrate	0.00%	0.97%

Picard Testing Laboratories, Inc.

From this table it was evident that a deposit of considerable body was filtering out on the outside and inside windings of our beams during the dyeing process. This deposit was quite insoluble and difficult to remove since it remained on the yarn after much washing and scouring at temperatures near the boil. Further, this deposit was retarding the flow of dye liquor through the beams to the extent that the middle windings from the beams were being dyed a lighter shade than the windings from the outside and inside.

A Look at the Dyeing Process Being Used

Either the dyestuff, or some chemical or agent other than dye, was causing this deposit on the yarn. The process in general use, in brief, called for a preliminary boil out of the yarn with a penetrant, then cooling to the proper dyeing temperature at which time the dye in pigment form was added. After a short time caustic soda was run in and this was later followed by hydrosulfite.

A check was made after each step in the process to determine where the deposit first appeared. This was found to be shortly after the caustic soda was added which indicated that the formation of some insoluble hydroxide or hydroxides was the beginning of the trouble.

That hydroxides actually were being formed on the dyed yarn is further indicated by the following letter from D. C. Picard, President of Picard Testing Laboratories, Inc.

Mr. M. T. Barnhill,
Sylacauga, Alabama
Dear Mr. Barnhill:

We are attaching the various analyses made in connection with the investigation of the trouble you were having by precipitation of minerals on a yarn that was being dyed.

The ash in this raw yarn is a trifle over 1%, which appears to be a normal percentage for our cottons. However, it is my personal belief that the extensive use of modern purely chemical fertilizers has changed the composition of the natural ash of the lint, with a lowering of carbonate and an increase in sulfate, chloride and phosphate, and evidently an increase in magnesium, due to the preference of fertilizer manufacturers for Dolomite over limestone to produce basicity in the mixtures.

This, together with the water used in dyeing, as well as the original pre-dyeing treatment, may have produced conditions with which none of us have heretofore been familiar. Both you and Mr. Davidson (of du Pont) and myself agree on this point. The water is zeolite treated, and though this removes largely both lime and magnesia, as well as iron and aluminum, the interchange produces a corresponding amount of sodium bicarbonate.

Either the water itself with the ash combination of the cotton, or the combination of these together with the chemicals added for the pre-dyeing treatment* seemed to have caused a secondary precipitation of the residual lime and magnesia as hydrates on the fibers. These hydrates are practically insoluble in water. This may seem a very far fetched theory, but two most careful analyses of the ash of the dyed yarn (the average is reported) did not give enough carbonate, chloride, sulfate and phosphate to combine with the bases therefore, the precipitation of lime and magnesia as hydrates is the only possible theory. At any rate, in balancing the analysis of the ash, the difference between actual determinations and the amount of ash will even up only by combining part of the lime and magnesia as hydrates. . . .

(The letter included more information but it is unrelated and need not be included here.)

. . . . . .

Very truly yours,
D. C. Picard, President
April 30, 1946.

* At the time this letter was written Mr. Picard was of the opinion that this deposit was forming on the yarn during the preliminary boiling out and not during the dyeing.

If the calcium and magnesium being precipitated on the yarn was actually coming from the yarn and not from the water supply, the removal of this material in the preliminary boil out of the yarn should correct the trouble. Dilute acetic acid should convert the calcium and magnesium to soluble acetates which could easily be washed out of the yarn. The following table illustrates what took place when some of this yarn was given a boil out with dilute acetic acid at 180 F.

TABLE SHOWING CHEMICAL ANALYSES OF WATER

	Zeolite Treated water prior to boiling out yarn	*Same water after boiling out yarn with penetrant*	*Same water after boiling out yarn with dil. acetic*
	Parts per Million	*Parts per Million*	*Parts per Million*
Silica	9.2	8.5	14.4
Iron	0.4	3.5	8.2
Aluminum	0.8	8.0	15.4
Calcium	3.8	5.1	14.6
Magnesium	1.7	11.7	23.6
Sodium	68.7	34.9	57.9
Potassium	0.8	10.8	31.7
Carbonate	0.0	0.0	Trace
Bicarbonate	157.5	59.9	0.0
Sulphate	19.8	68.7	101.2
Chloride	15.3	56.7	69.2
Phosphate	Trace	0.4	20.1
Acetic	0.0	0.0	195.2 (By difference)

Picard Testing Laboratories, Inc.

The tests shown in the preceding table were conducted with a dye bath volume of 300 gallons; the beam weight in each case was 250 pounds of yarn.

The first column in the table gives the analysis of the original softened water.

The second column shows the increase in mineral content of this same water after boiling out a beam of yarn with the customary addition of a penetrant.

The third column shows the increase in mineral content of the original water after boiling out a beam of yarn with dilute acetic acid in the bath.

After studying this table it is obvious that the acetic acid treatment removed considerably more mineral matter from the yarn than did the regular boil out with a penetrant. It is also an actual fact that the beams boiled out with the acetic acid no longer showed the dirty deposit on the yarn after dyeing.

Analysis of Results and Final Conclusions

The construction of the finished cloth in many instances is the determining factor in concluding whether a dyeing is satisfactory or unsatisfactory. In fabrics in which most of the color is in the warp this is particularly true. For instance, in dyed stripes if the stripe is narrow, unevenness in the dyeing is often imperceptible. On the other hand, if the stripes are wide or if the entire warp is of one color, unevenness in the dyeing will become more apparent. In such cloth variations in depth of shade from the outside windings to the middle windings of a dyed beam will produce too many shades of each pattern to handle economically in the cloth room.

In this research we were dealing with a high-count fabric in which the entire warp was often of only one medium or pastel shade. It was therefore necessary for each dyeing to be extremely level to meet requirements.

Cotton grown in different localities will often vary in certain properties. One of the more troublesome differences is the fact that two cottons may be apparently alike and yet one will dye differently from the other in the same dyebath. The Southern Regional Research Laboratory in New Orleans is at present conducting research to determine why this phenomenon can be.

Our work illustrates rather strikingly that two high quality American cottons can vary sufficiently in the structure of their mineral content to effect results in dyeing in beam dyeing equipment. The small amount of calcium and magnesium present in the 1" staple cotton was in an insoluble form difficult to remove. These same elements in the 1-1/16" staple cotton were in some form that allowed them to be readily removed in an alkaline dye bath and subsequently redeposited on the outside windings of the beams as an insoluble hydroxide. This deposit became firmly fixed on the yarn and could not be removed by soaping.

Before yarn made from the 1-1/16" cotton could be dyed with vat dyes on beams satisfactorily it was first necessary to give the yarn a preliminary boil-out with dilute acetic acid. This boil-out removed the troublesome portion of the calcium, magnesium, and lesser amounts of certain other elements from the yarn. Thus prepared, this yarn could be dyed a very level shade free of any deposit; without this treatment no combination of agents or conditions was ever found that was effective.

Special Mention

The Committee owes a debt of thanks to E. P. Davidson of E. I. Dupont de Nemours & Co., Inc. for much vital help and many valuable suggestions helpful in the completion of this work.

D. C. Picard of The Picard Testing Laboratories, Inc., was another gentleman greatly interested in the project. His help was of much value.

Related Literature and Information

The following interesting information was furnished by E. P. Davidson of E. I. Dupont de Nemours & Co., Inc., from their library of reference books.

From a U. S. Dept. of Agriculture Publication

Typical cotton averages 1.2% ash with extremes of 0.7% to 1.6%. This ash is composed of the following.

K_2O	34%
CaO	11%
MgO	6%
Na_2O	7%
Fe_2O_3	2%
Al_2O_3	2%
SiO_2	5%
SO_3	4%
P_2O_5	5%
C1	4%
CO_2	20%
Cu	Trace
Mn	Trace

"Chemistry & Practice of Finishing" Volume 1, 3rd edition, dated 1926 by Percy Bean, states mineral matter in cotton is about 1% and the average composition of the ash is as follows:

Carbonate of Potassium	44.8%	water soluble
Chloride of Potassium	9.9%	water soluble
Sulfate of Potassium	9.3%	water soluble
Phosphate of Magnesium	8.4%	water insoluble
Carbonate of Calcium	10.6%	water insoluble
Phosphate of Calcium	9.0%	water insoluble
Peroxide of Iron	3.0%	water insoluble
Alum traces and loss	5.0%	water insoluble

"The Bleaching, Dyeing & Chemical Technology of Textile Fibres" dated 1925 by S. R. Trotman states the average percentage of ash in American cotton is 1.19% and in Sea Island cotton is 0.99%. Indian cottons vary from 1.34% to 3.99%.

The average composition of the ash in a Bombay cotton is as follows:

Silica	15.66%
Alumina	10.80%
Iron Oxide	5.89%
Lime	9.75%
Magnesia	1.87%
Potash	27.32%
Soda	4.51%
Sulfates (SO_3)	1.96%
Phosphates (P_2O_5)	3.26%
Chlorine	6.55%
CO_2	12.19%

"Cotton-Cellulose" dated 1924 by A. J. Hall states cotton contains about 1% ash. A typical sample of Sea Island cotton with 1% ash had the following composition:

Potassium Carbonate	44.8%
Potassium Chloride	9.9%
Potassium Sulfate	9.3%
Calcium Phosphate	9.0%
Calcium Carbonate	10.6%
Magnesium Phosphate	8.4%
Iron Oxide	3.0%
Alumina and Loss	5.0%

CELLULOSE AND CELLULOSE DERIVATIVES
EMIL OTT, Editor
CELLULOSE TESTS
Clifford B. Purves
ASH

The sample, 2 to 10 g. (often that recovered from a moisture determination),

is weighed into a crucible, which may be of platinum, alundum, porcelain, or silica, although platinum should be avoided if zinc and some other heavy metals are present. A lid is fitted on the crucible and by preference, the incineration is carried out in a muffle furnace kept at 500 to 600 C. If a burner is used, cautious initial heating of the lid will control the formation of voluminous, tarry decomposition products. The cover may be removed to complete the oxidation of the residual carbon, after which the crucible and contents are cooled in a desicator and reweighed.

The ash from native cellulose usually contains two or more of the following metals, which are present as oxides, phosphates, or carbonates: sodium, potassium, calcium, magnesium, silicon, and traces of iron, together occasionally, with traces of several other heavy metals. The ash from the first four of these constituents dissolves in water and produces an alkaline solution. In order to determine the ash alkalinity, the entire ash is warmed for 1 hr. with 10 to 15 cc of 0.01 N. sulfuric acid, the mixture is diluted to 70 cc. with distilled water, and is titrated to a methyl red end point with 0.01 N caustic soda. The result is expressed as cc. of N acid required to neutralize the ash from 100 g. of sample or, alternatively, as the amount required for 1 g. of ash. Since the water-soluble oxides and carbonates in the ash were originally present as salts of carboxylic acids, it is easy to understand why the ash alkalinity is closely connected with the number of carboxyl groups in the sample and with its affinity for methylene blue and other basic dyestuffs. It is a common observation that the neutral calcium and magnesium salts of polybasic acids are less soluble than the sodium or potassium ones, probably because the dibasic anions form a bridge between two carboxylic groups belonging to different molecules. The sodium salts of pectic acid or of suitably oxidized cellulose, for example, are freely soluble in water but the barium or magnesium salts are insoluble. Such cross linkages between different macromolecules may affect the physical properties of cellulose that depend upon the size of the ultimate physical particle. If, for example, a cellulose ester or ether contains an occasional carboxyl group, cross-linked to another through a dibasic metal, the viscosity observed in a neutral organic solvent might be substantially enhanced. Decomposition of the salt by dilute acid, or dissociation by diluting the solution, might be expected to reduce the viscosity toward its ash-free value. Effects like these were observed by Rogovin and Schlachover for cellulose nitrate-calcium oxide systems, although they interpreted their data in terms of calcium alcoholates rather than calcium salts.

The neutral, insoluble ash constituents represent for the most part inorganic materials that originally were occluded in the fiber. In addition to diminishing the clarity of solutions of cellulose and its derivitives, these constituents may enter as catalysts into various reactions. One conspicuous example is the efficiency of traces of copper or manganese in catlyzing the oxidative breakdown of rayon textiles, particularly when the rayon is impregnated with rubber. Fabrics destined for the latter process must not contain more than 0.001% of copper or 0.0005% of manganese. Since these minute amounts may readily be acquired from water supplies, metallic equipment, or other chemicals during processing, the detection and estimation of the nonsoluble ash constituents has attracted considerable attention. Micro methods have been developed for copper, zinc, and iron, titanium and iron, and arsenic, lead, and copper. In some of these methods, the organic material in the sample is destroyed by digestion with nitric acid instead of by incineration.

To sum up, the ash constituents of cellulose may modify its properties to an extent altogether out of proportion to their absolute amount, which rarely exceeds a few tenths of 1%.

A Message
from Your President

HENRY F. HERRMANN

I AM glad of this opportunity to thank all my friends in the New York Section for having made my election to the presidency of our association possible. Naturally, I feel particularly honored by the confidence shown in me by the host of members in the other sections in choosing me as their leader. We have no inaugural ceremony and there is no oath of office. Therefore, I consider it fitting to utilize my first official utterance as your President for a pledge of faithful service to our Association. You will understand the touch of sentiment I feel in making this acknowledgment of appreciation of high responsibility from this platform, which reminds se so intimately of the many years we have met here and worked together in the common cause.

Honors in these cases are but mandates to serve and I approach my duties with a deep sense of the need our Association has for wise and painstaking service. We have grown to such proportions and are so well known nationally that lapses of duty or errors of judgment may carry with them serious consequences. With the wholehearted support of the entire membership and the wisdom of our Council to help me, the administration should not fail.

We are first and foremost a Scientific Society. We have called on the Industry for the financial support of our research activity on the basis of its merit and importance to the science and practice of dyeing, printing and finishing, and the manifold associated operations with which it is concerned. We are receiving this support and must realize our obligation to continue to earn it. Only if we merit support can we expect to receive it. Only in the degree that we grow in scientific stature will we command the respect of industry on a nation wide basis, and of our fellow technical associations who are vieing for the leadership which we claim in our chosen field.

To foster our growth and research program we need a strong central administrative body, which we have, and will endeavor to build up further. However, this is not enough. Important as councils and committees may be, they are merely the crystallization of the society as a whole. You—each and all of you—those here and the 4,500 members of our other sections, are the mother of these crystals. Leaders are helpless without followers. The greatest achievement which any administration can hope to accomplish is to imbue the entire association with a realization of its vital importance and the mandate which each and every member has accepted to contribute his share to the big job which we all agree should be done well.

The strength of our national body rests on the wholesomeness of the Sections. National research achievement is merely the consolidation of local efforts and toils of individuals, singly or in small groups. Membership in our Association is the first step toward our ultimate goal that every member will be a real co-worker. With that accomplished—who can stop us?

* Presented to the members of the New York Section at their meeting on January 31st.

A Correlation of Water-Repellent Garment Performance and Laboratory Penetration Tests on Fabrics*

GEORGE A. SLOWINSKE and ARTHUR G. POPE

Fine Chemicals Division, Technical Laboratory
E. I. du Pont de Nemours & Co., Inc.

The authors are greatly indebted to the Office of the Quartermaster General and the Philadelphia Quartermaster Depot for the privilege of using the Depot Rain Room and additional laboratory facilities. Special acknowledgment is due Messrs. Stanley Backer and M. I. Landsberg of the Depot staff for their helpful cooperation. Acknowledgement also is due to the Southern Regional Research Laboratory at New Orleans. The Bundesmann Test results reported here were obtained at that laboratory by the senior author with the cooperation of Dr. Ruby K. Worner. Appreciation also is expressed to the Delta Finishing Company of Philadelphia for the preparation and processing of the fabrics studied, and to Raingard, Inc. of New York City for construction of the test garments.

THE problem of water-repellent or water-resistant garment performance has aroused considerable interest in the last five years. Hundreds of millions of yards of water-repellent fabrics were used by the Army. Such fabrics prevent or minimize the penetration of rain, yet permit the passage of air and water vapor. Consequently, garments made from such fabrics have a much wider range of usefulness than garments made from coated or waterproof† fabrics.

The impetus produced by the war effort resulted in the design of new fabrics and garments and the introduction of new test methods. The accelerated introduction of new laboratory test procedures, however, caused considerable confusion. New test methods were developed and attempts were made to use each method, to the exclusion of others, for the establishment of trade standards. But claims made for any one individual instrument could not be compared directly with those made for other instruments. The problem faced by the AATCC Committee on Water Resistance of Fabrics[1] was typical. At the start of 1946, the committee had seven different water penetration testers under consideration. Two were tests already adopted by the committee and five were newer tests developed by different workers in the field. The committee as a whole agreed that all seven of the testers had merit. But the relative values of the instruments could not be agreed upon. In addition, the committee had no satisfactory method of developing information or test data which could be used to predict whether or not a particular fabric would keep the wearer dry in a rain of particular intensity or duration.

All of the water-repellency tests used at the present time or described in the literature can be divided into two main classes as follows:

Class I

Tests which measure resistance to wetting of the fabric and its fibers.

Class II

Tests which measure resistance to penetration of water *through* the fabrics.

The tests which fall into Class I are well suited to the evaluation of water-repellents. They measure the property which such agents impart to textiles—resistance to wetting of the fibers and yarns. They are influenced to only a minor degree by yarn or fabric construction. A partial list would include the AATCC Spray[2,3] Test, the AATCC Immersion Absorption[2,4,18] Test, the Army Dynamic Absorption[5] Test, the Baxter and Cassie Wetting Time[6] Test, and contact angle procedures described in the literature by numerous investigators.

The tests which fall into Class II are intended to evaluate the probable use performance of treated fabrics. The results obtained with them are dependent on both the fiber and yarn water resistance imparted by the proofing agent, and the construction of the fabrics. As early as 1924 Pearson stated the same thing as follows:

> "Similarly the resistance to penetration of a water-resistant rain coating, for instance, depends on: (1) The thickness of the fabric, i.e., the length of the pores or holes in the fabric. (2) The diameter of the pores or holes. (3) The pressure of the water to which the fabric is subjected. (4) The efficacy of the treatment given to the fabric."

The present paper involves a study of the relationships between laboratory penetration tests (those falling in Class II) only, and the performance of cotton garments. It was made possible by the development during the war of a Rain Room or Rain Course at the Philadelphia Army Quartermaster Depot.

A total of seventy cotton raincoats made of combinations of seven different cotton fabrics were tested in the Rain Room. The garments were worn by human subjects under simulated rains of two intensities. The fabrics going into the garments were evaluated by means of five different laboratory water penetration tests: the AATCC Hydrostatic

* Presented at meeting, New York Section, January 31, 1947.

† The authors believe that the terms "water-resistant" and "water-repellent" are used interchangeably by the trade. They also subscribe to the following definitions given by H. P. Pearson ("Waterproofing of Textile Fabrics," p. 8, The Chemical Catalogue Company, 1924):

"Waterproof means: Impervious to water, and air-resistant. Water-resistant means: Resistant to water and porous to air."

Pressure Test, the AATCC Impact Penetration Test, the Bundesmann Test, the Drop-Penetration Test and the new Du Pont Rain Test. The water-repellent treatments on the fabrics were evaluated by means of the AATCC Immersion Absorption Test and the AATCC Spray Test. In addition, the treated fabrics were subjected to air permeability, thickness, weight, and yarn count measurements.

DESCRIPTION OF RAIN ROOM AND LABORATORY WATER-PENETRATION TESTS

Rain Room

The Rain Room used in this work is a semi-permanent installation at the Philadelphia Quartermaster Depot. Its construction and properties were described in a published article[7] by M. I. Landsberg and F. J. Moody. A photograph, taken during the tests described in this paper and illustrating the general set-up, is given in Figure 1. Essentially, the Rain Room consists of a tower from which simulated rain is supplied by means of nozzles, and a floor area on which garments or fabrics may be tested on stationary forms or on human subjects in motion. The nozzles are placed at different heights from the floor, varying from 23.75 feet to 27.25 feet. They reproduce simulated rains of 0.1, 1 and 3 inch per hour intensity. In this connection, Landsberg and Moody state[7]:

> "The nozzles developed, although not perfect in their reproductions of actual weather conditions, furnish simulated rainfall with respect to the three most important features; intensity, drop sizes and velocity having the same order of magnitude as those found in natural rainfall."

Laboratory Penetration Tests

1. Rain Test

The Rain Tester is a new instrument developed in the Du Pont Technical Laboratory during the course of work on durable water-repellent finishes for the Army and Navy. The present model has not been described previously in the technical literature. However, some results obtained with an earlier model were made public by Slowinske[8,9,10] and by Sookne, Minor, Simpson and Harris[11]. It is essentially a device for testing the penetration resistance of fabrics by the use of different intensities of water impact. In this one respect it is markedly different from other instruments, such as the Bundesmann and Drop-Penetration testers, which subject the fabric to falling water drops of a single intensity.

Figure 2 is a photograph of the complete instrument and accessory equipment. Figure 3 is a close-up showing the water spray impinging on the test fabric. Figure 4 is a schematic drawing showing the main features of the instrument. A complete detail engineering drawing is available and may be obtained from the authors.

Tests are made at different intensities of water impact in order to obtain a complete over-all picture of the penetration resistance of a fabric or combinations of fabrics. The intensities are produced and controlled by means of a column of water which may be adjusted to heights of 2, 3, 4, 5, 6, 7 or 8 feet above the nozzle. This is done by means of a glass pressure column to which the nozzle is connected (see the photograph in Figure 2 and the drawing in Figure 4). The adjustment of the

Courtesy of Photo Section, Phila. Q. M. Depot

Fig. 1—Rain Room

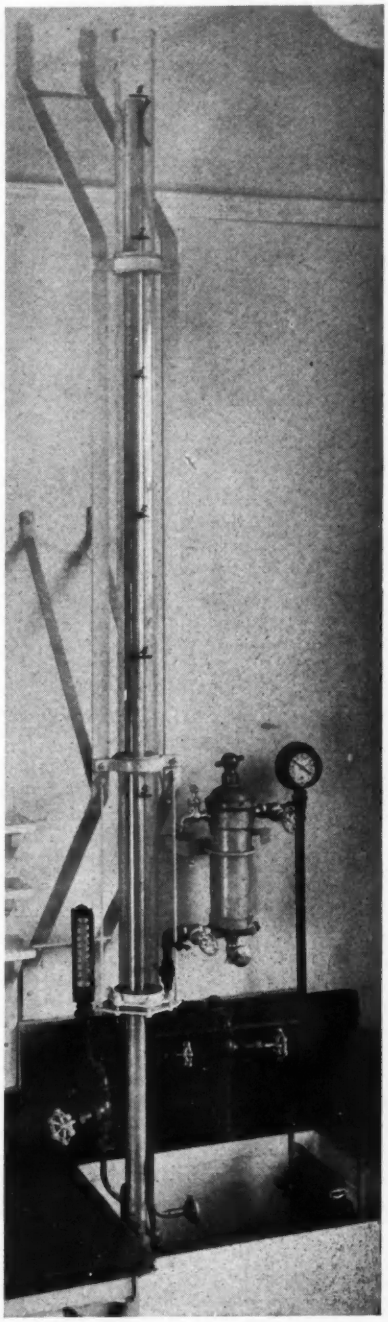


Fig. 2—Rain Tester (Complete Assembly)

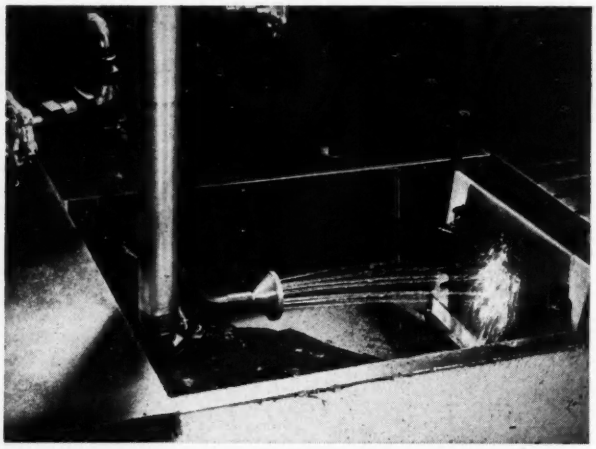


Fig. 3—Rain Tester (Close-up of Water Spray)

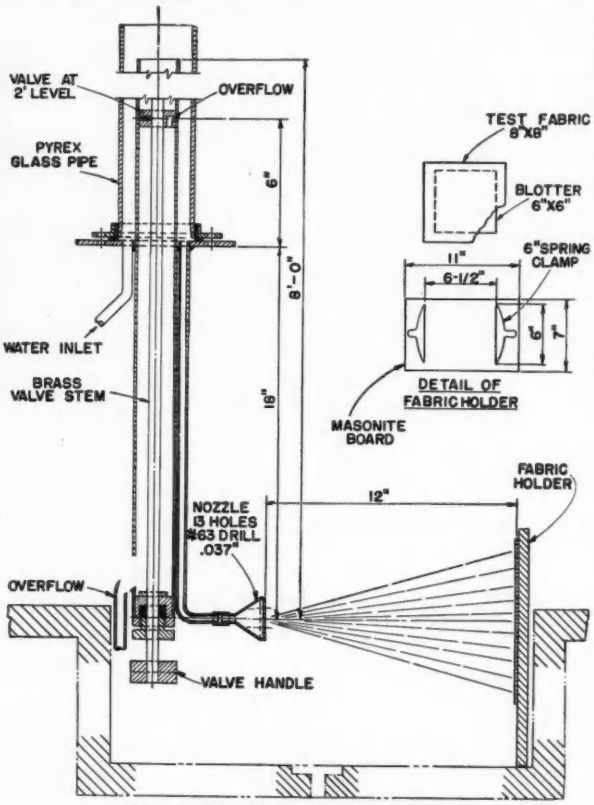


Fig. 4—Rain Tester (Structural Details)

height of the water in the glass pressure column is made by a simple setting of a valve at the lower end of a drain or overflow pipe which extends up through the center of the glass pressure column (see the drawing in Figure 4).

The supply water for the instrument enters at the bottom of the glass pressure column. This water is supplied by two faucets (hot and cold) in order to maintain a temperature of 80 ± 2°F.* The water is filtered before entering the instrument (see the photograph in Figure 2).

The test fabric is cut to a size of 8 inches by 8 inches and clamped on the sides in the fabric holder (see Figure 4). Behind the fabric is placed a weighed paper blotter of 6 inch by 6 inch size. The blotter meets the specifications of that used in the AATCC Tentative Standard Immersion Absorption Test[4]. Single or double thicknesses of the same fabric, or combinations of two or more fabrics, may be tested. (The blotter itself may be replaced by a layer or layers of selected fabric, if a more resilient support for the material under test is desired. The supporting fabric may be absorbent or non-absorbent.) The back of the fabric holder may be of "Masonite" board as indicated in Figure 4, or it may be of metal, glass or transparent plastic.

The fabric holder (with the test fabric and desired backing material) is placed vertically in a rigid support frame (see Figure 3). A horiontal water spray is directed against the test fabric from the spray nozzle. The distance from the nozzle to the test fabric is 12 inches. The water which penetrates through the fabric is absorbed by the blotter. The increase in weight of the blotter is determined by weighing. Ordinarily, three specimens of each treatment are tested to give an average, although in the present work an average of nine specimens was obtained.†

An alternative test procedure which can be used with the Rain Tester involves running the test for successive periods of time so that penetration can be plotted against time. The time required to start leakage can also be determined when the back of the fabric holder is made of a transparent material. The latter procedure is sometimes desirable in testing fabrics or fabric combinations of high penetration resistance.

2. Bundesmann Test

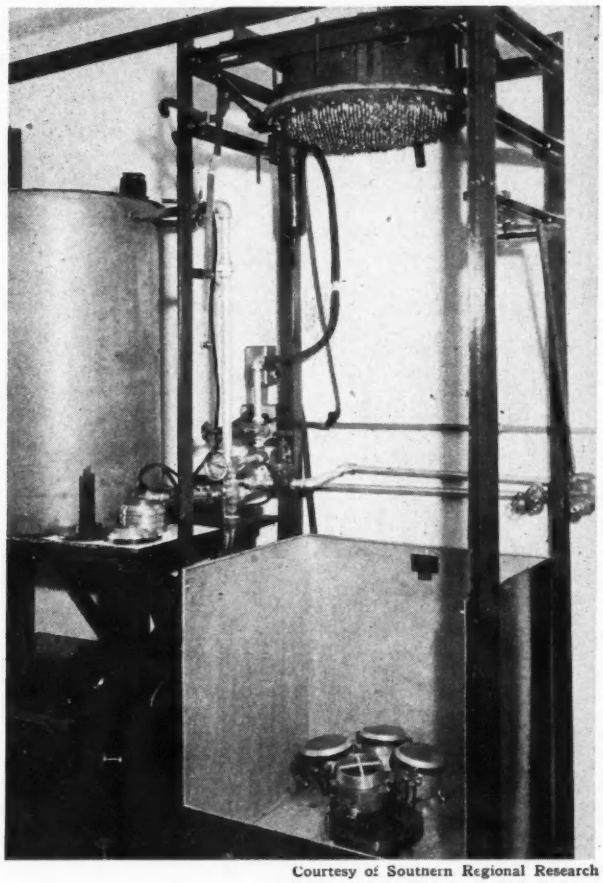
The Bundesmann Tester is well known in Germany and England. Probably the first complete description of it was made by Bundesmann[12] in 1935. The particular instrument used in this work was made in England to conform to the requirements of "Tentative Textile Standard No. 7" of the British Textile Institute.[13] The procedure used with the instrument was that described in "Tentative Textile Standard No. 8" of the Textile Institute, with the exception that the testing time was increased from 10 minutes to 20 minutes in an attempt to evaluate more adequately the series of fabrics used in this work.

A photograph of the model used is given in Figure 5. Essentially the instrument consists of a shower tank or drop-forming device and four cups or receptacles over which specimens of the fabric are placed under controlled tension. The

* In order to conform to AATCC practice, all laboratory tests involving the use of water were run at 80°F. They included the Spray, Immersion Absorption, Rain, Impact Penetration, Hydrostatic Pressure, Drop-Penetration, and Bundesmann tests.

It was not practical to employ a temperature control device on the water supply used in the Depot Rain Room Work. However, measurements made during the course of the work gave readings between 73°F. and 76°F.

† The sampling method used in this work may be of interest. All of the fabrics reserved for the laboratory tests were pieces over 50 yards in length. Sampling was done at three points in the piece—at the center and at points about 10 yards in from each end. At each point three specimens were taken—at the center line of the fabric and at points on each side no nearer the selvage than one-tenth the width of the fabric. The nine specimens taken in this way were used to obtain the averages reported in this paper for the properties of air permeability, thickness, weight, width, yarn count, and performances in the laboratory Spray, Immersion Absorption, Rain, Impact Penetration, and Hydrostatic Pressure tests. The same sampling method was followed for the Drop-Penetration and Bundesmann tests, although in some cases it was deemed advisable to decrease the number of specimens for the sake of convenience or to avoid the consumption of excessively long times. For example, it is convenient to run the Bundesmann Test on eight specimens rather than nine, since the instrument has four specimen holders. In addition, both the Bundesmann and Drop-Penetration tests required times of over one hour to obtain a significant reading for some fabrics or combinations of fabrics.



Courtesy of Southern Regional Research Lab., U. S. Department of Agriculture

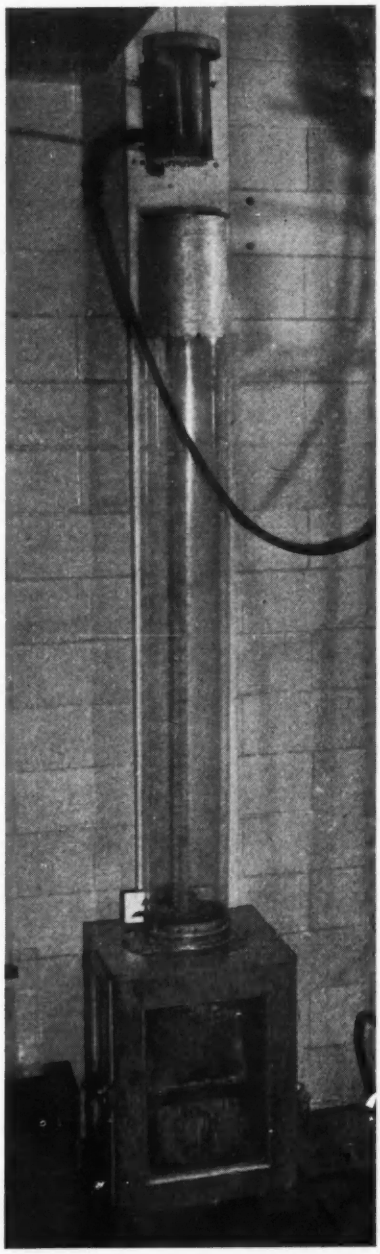
Fig. 5—Bundesmann Tester

four cups are mounted on a central pin which rotates them at 5 R.P.M. Each cup is fitted with a wiper arm which rubs the underside of the fabric specimen. The height from which the water drops fall onto the fabric specimens is 150 centimeters (approximately 4 feet 11 inches). The water which penetrates through the fabric specimens is collected in the cups. At the end of the test, the water is drained out of the cups and measured volumetrically.

3. Drop-Penetration Test

The Drop-Penetration Tester was developed during a Textile Foundation Research Associateship at the National Bureau of Standards. Its construction, properties and performance were described in an article by Sookne, Minor, Simpson and Harris.[11] It also is described in a supplement[5] to Federal Specification CCC-T-191a. The testing procedure used in this work was that specified in the CCC-T-191a supplement, and described as the "hard backing" procedure by Sookne and colleagues.

A photograph of the model used is given in Figure 6. It consists essentially of a drop-forming device, a support for the test specimen, and means for collecting and measuring the penetration of water. The distance between the lower end of the capillaries which form the drops to the center of the fabric sample is 5 feet 8 inches. The drops are protected from air currents during their fall by a cylindrical shield. The fabric support is a "Bakelite" plate mounted at an angle of 45 degrees. The fabric specimen is held over the plate by means of a fixed clamp at the upper edge of the plate and a second clamp which hangs freely over the lower edge of the plate. The water which penetrates through the fabric runs out through a slot near the lower edge of the plate, and is collected and measured. The time required for 10 cc. of water to penetrate is determined.



Courtesy of Photo Section, Phila. Q. M. Depot

Fig. 6—Drop-Penetration Tester

4. Hydrostatic Pressure Test

The Hydrostatic Pressure Test is an Official Standard of the AATCC.[14] It was first described in the "American Dyestuff Reporter" in a previous paper.[2] The procedure used with it was that described in the 1945 AATCC Year Book.

A photograph of the model used is given

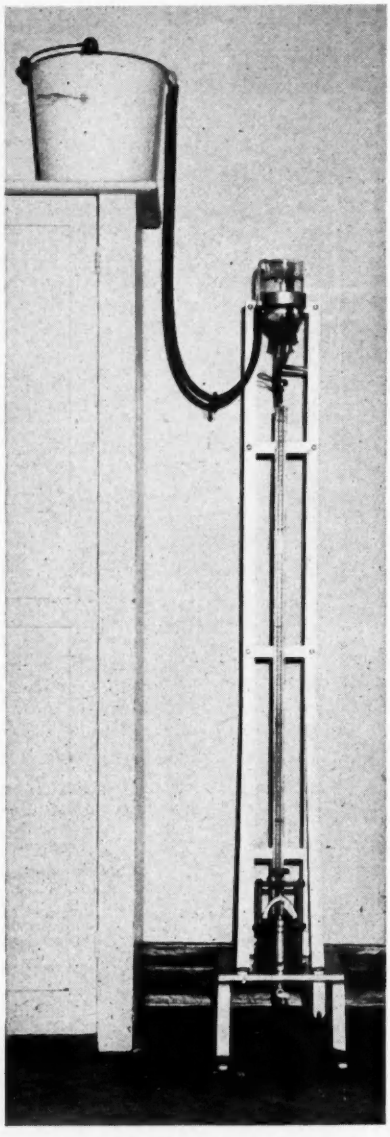


Fig. 7—AATCC Hydrostatic Pressure Tester

in Figure 7. Essentially the instrument consists of a holder connected to a pressure column, and means for running water into the pressure column at a uniform rate. The height of water reached in the pressure column when leakage starts through the test specimen is observed and recorded.

5. Impact Penetration Test

The Impact Penetration Test is a Tentative Standard of the AATCC.[15] It was first described in the AMERICAN DYESTUFF REPORTER in a previous paper.[16] A similar test was described in an AATCC Intersectional Contest paper.[17] The procedure used in this work was that described in the 1945 AATCC Year Book.

A photograph of the model used is given in Figure 8. Essentially the instrument consists of a funnel and attached nozzle for producing a water spray, a support for the test specimen, and means for measuring the water which penetrates. The distance from the bottom of the nozzle to the center of the fabric support is 2 feet. The fabric support is a steel plate mounted at an angle of 45 degrees. The fabric specimen is held over the plate by means of a fixed clamp at the upper edge of the plate and a second clamp which hangs freely over the lower edge of the plate. A standard, weighed paper blotter is placed under the test specimen on the support plate. The water spray for the test is produced by pouring 500 cc. of water into the funnel. The water which penetrates through the fabric is absorbed by the blotter and weighed at the end of the test.

EXPERIMENTAL WORK AND DATA

Preparation of Test Fabrics and Garments

At the start of the work seven different plain woven cotton fabrics were purchased in the grey state from different commercial sources. The fabrics varied in length from 100 yards to over 200 yards. They were selected on the basis of preliminary work to represent a range of water penetration resistance. They all were of the type used in rainwear, either by the commercial trade or by the Army. They included poplin, twill, gabardine, sateen and oxford constructions.

The grey fabrics were sent to a finishing mill where they were desized, boiled-off, mercerized, and dyed a tan shade with vat dyes under the same conditions. Next the fabrics were treated with a commercial durable-type water repellent[18] under uniform conditions, and finally preshrunk ("Sanforized").

Parts of the fabrics were retained for laboratory tests, and the remainders were used to construct standard raincoats. The latter operation was carried out by a well-qualified garment manufacturer. Five skeleton-type raincoats were made with each of the seven different fabrics. Also, five quarter-lined (sometimes called half-lined) raincoats were made with each of the seven fabrics. The skeleton-type garments were made from a single thickness of fabric with no lining whatsoever. The seams used were closed lap seams (seams raised and bent). The quarter-lined garments possessed a quarter-lined front and back, and were also lined in the sleeves.

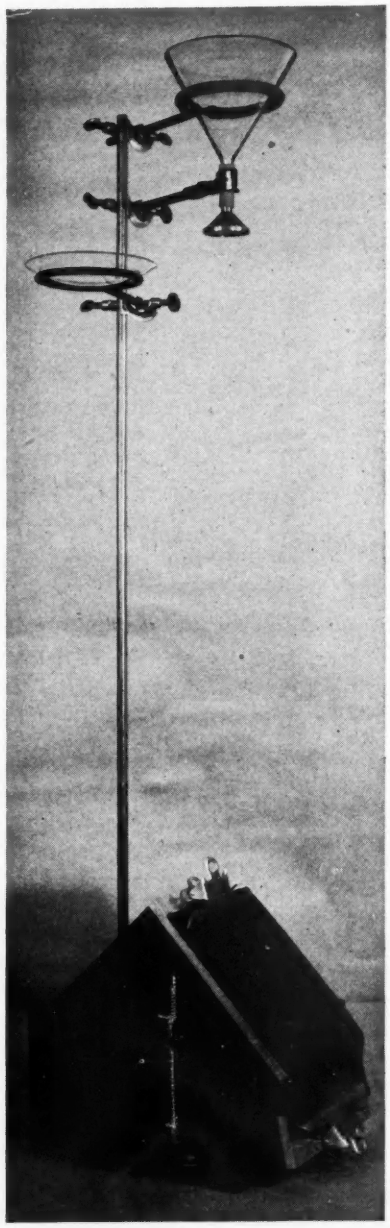


Fig. 8—AATCC Impact Penetration Tester

The lining in each case was made from the same treated fabric as that used for the outer shell. Plain seams were used in the lining while the outer shell was constructed with closed lap seams (seams raised and bent).

The total of seventy raincoats were all of the same size, and of box drape style with a convertible collar, set-in sleeves, and cut-through slash pockets. The raincoats were sewn with mercerized, vat dyed

Fig. 9—Skeleton and Quarter-Lined Raincoats

thread which had been treated in the laboratory with the same durable water repellent as that used on the fabrics. (A few seams were inadvertently sewn with untreated cotton sewing thread.)

For the sake of convenience, the skeleton-type coats will be referred to as single-thickness coats and the quarter-lined coats will be referred to as double-thickness coats throughout the rest of this paper. Figure 9 is a photograph showing each type of coat.

Determination of General Properties of Test Fabrics

The seven cotton fabrics in the finished state were subjected to the AATCC Spray[2, 3] and Immersion Absorption[2, 4, 18] tests in order to determine the efficiency of the water-repellent treatment. The air permeabilities, thicknesses, widths, weights, and yarn counts also were determined on the finished fabrics. The air permeability measurements were made by means of the procedure described by Schiefer and Boyland,[19] and specified in the October 8, 1945 Supplement to Federal Specification CCC-T-191a. The thickness measurements were made with a Randall & Stickney Thickness Tester which was checked against an Ames No. 25 Thickness Tester. The weight measurements were made by accurately weighing specimens cut to a size of 6 inches by 6 inches. The data obtained are given in Table I. It should be noted that the Spray Test data indicate that the fabrics were equally well treated, and that the Immersion Absorption Test data show only slight differences which are believed to be due to the constructional differences between the fabrics.

Garment Evaluation in the Rain Room

The garment evaluations were carried out in the Philadelphia Quartermaster Depot Rain Room, described earlier in this paper.

Preliminary work was carried out with one single-thickness raincoat and one double-thickness raincoat made of each of the seven different test fabrics in order to decide upon the best testing procedure. Also, the most practical method of recording the results was worked out with the helpful advice of Mr. M. I. Landsberg of the Philadelphia Quartermaster Depot. In addition, a rough ranking of the raincoats was obtained for use as a guide in planning the main program.

A surprising fault of the single-thickness garments was discovered during the preliminary work. As a result of a misunderstanding which occurred during the planning stage, an untreated viscose process rayon fabric had been used on the inside of the single-thickness coats to cover the seams at the junction of the sleeves and the body. The simulated rain penetrated quickly through those seams and wetted the absorbent rayon, which in turn wetted the clothing underneath. This penetration took place much quicker than penetration at other points. Since it was not practical to remove the untreated rayon it was decided to render it water repellent by a hand operation. This was tried out on a few of the single-thickness coats by "painting" the rayon with a wax emulsion type repellent, drying at room temperature, and then pressing with a hand iron. The coats so treated performed satisfactorily when re-tested in the

TABLE I

Spray, Immersion Absorption, Air Permeability, Thickness, Width, Weight and Yarn Counts of Finished Fabrics

Fabric Code Number	Fabric Weave	Average Spray Test Rating	Average Immersion Absorption Test Value—per cent	Average Air Permeability—cu.ft./min./sq. ft.	Average Thickness—thousandths of an inch	Average Width—inches	Average Weight		Average Count per Inch	
							oz./sq.yd.	lbs./linear yd.	Warp	Filling
1	Poplin	100	20.9	7.34	15.6	38.1	6.20	2.44	107	54
2	Sateen	100	17.7	4.72	22.8	36.5	8.78	1.80	112	70
3	Oxford	100	19.3	2.37	19.1	33.8	8.50	2.01	132	49
4	Poplin	100	22.6	9.15	12.6	35.5	4.86	3.34	109	63
5	Poplin	100	23.2	60.0	14.2	35.8	4.39	3.67	117	42
6	Twill	100	22.9	40.3	16.1	35.5	5.21	3.12	118	55
7	Gabardine	100	20.6	27.6	28.7	36.1	9.06	1.76	133	75

TABLE II

Rain Room Data Obtained With 1 Inch Per Hour Simulated Rain

	Test Raincoat		Successive Inspection Times - Minutes from Start of Test	Initial Wetting of Suitcoat Under Raincoat		Serious Wetting of Suitcoat Under Raincoat	
	Code No.	Construction		Area or Areas Wetted	Inspection Time - Minutes From Start of Test	Area or Areas Wetted	Inspection Time - Minutes From Start of Test
Single-Thickness	3W	No. 3 Oxford	15,30,45,60,75,90,105,120	None	120	None	120
	3X	" " "	15,30,45,60,75,90,105,120	None	120	None	120
	3Y	" " "	15,30,45,60,75,90,105,120	1 small area upper back	90	(Note 1)	120
	2W	No. 2 Sateen	15,30,45,60,75,90	2 small areas upper back	75	3 large areas upper back and 1 large area upper front	90
	2X	" " "	15,30,45,60,75,90,105,120	None	120	None	120
	2Y	" " "	15,30,45,60,75,90,105	4 small areas upper back	90	4 large areas upper back	105
	1W	No. 1 Poplin	15,30,45,60,75	3 small areas upper back	45	1 large and 7 small areas upper back	75
	1X	" " "	15,30,45,60,75,90	3 small areas upper back	45	3 large areas upper back	90
	1Y	" " "	15,30,45,60,75	3 small areas upper back	45	3 large areas upper back	75
	4W	No. 4 Poplin	15,30,45,60,75	2 small areas upper back	30	2 large areas upper back and 1 large area upper front	75
	4X	" " "	15,30,45	2 large and 1 small areas upper back	30	3 large areas upper back	45
	4Y	" " "	15,30,45,60	3 small areas upper back	30	3 large areas upper back	60
	7W	No. 7 Gabardine	5,15	1 small area upper front	5	2 large areas upper back and 1 small area upper front	15
	7X	" " "	5,15	5 small areas upper back	5	3 large areas upper back	15
	7Y	" " "	5,15,30	3 small areas upper back	5	3 large areas upper back	30
	7Z	" " "	5,15,30,45	5 small areas upper back	5	3 large areas upper back	45
	6W	No. 6 Twill	5,15	6 small areas upper back	5	2 large areas upper back	15
	6X	" " "	5,15	2 large and 1 small areas upper back	5	3 large areas upper back	15
	6Y	" " "	5,15,30	5 small areas upper back	5	4 large areas upper back	30
	6Z	" " "	5,15	3 small areas upper back	5	2 large areas upper back	15
	5W	No. 5 Poplin	5,15	3 large areas upper back	5	Entire upper back and 1 large area upper front	15
	5X	" " "	5,15	10 small areas upper back	5	Entire upper back and 5 large areas upper front	15
	5Y	" " "	5,15	4 large areas upper back	5	Entire upper back and 3 large areas upper front	15
	5Z	" " "	5,15	6 small areas upper back	5	Entire upper back	15
Double-Thickness	7DW	No. 7 Gabardine	15,30,45,60,120	None	120	None	120
	6DW	No. 6 Twill	15,30,45,60,120	None	120	None	120
	5DX	No. 5 Poplin	15,30,45,60,120	None	120	None	120

Note 1

Serious wetting of the suitcoat was not noted at the end of the test (120 minutes). The single small wetted area noted at the 90 minute inspection time did not increase in area during the subsequent 30 minutes of exposure.

TABLE III

Rain Room Data Obtained With 3 Inch Per Hour Simulated Rain

Note 1

Serious wetting of the suitcoat was not noted at the end of the test (120 minutes). The single small wetted area noted at the 90 minute inspection time did not increase in area during the subsequent 30 minutes of exposure.

TABLE III

Rain Room Data Obtained With 3 Inch Per Hour Simulated Rain

	Test Raincoat		Successive Inspection Times - Minutes From Start of Test	Initial Wetting of Suitcoat Under Raincoat		Serious Wetting of Suitcoat Under Raincoat	
	Code No.	Construction		Area or Areas Wetted	Inspection Time - Minutes from Start of Test	Area or Areas Wetted	Inspection Time - Minutes From Start of Test
Double-Thickness	3DW	No. 3 Oxford	30,60,90,120	None	120	None	120
	3DX	" " "	30,60,90,120	None	120	None	120
	3DY	" " "	30,60,90,120	None	120	None	120
	3DZ	" " "	30,60,90,120	None	120	None	120
	2DW	No. 2 Sateen	30,60,90,120	None	120	None	120
	2DX	" " "	30,60,90,120	None	120	None	120
	2DY	" " "	30,60,90,120	None	120	None	120
	2DZ	" " "	30,60,90,120	None	120	None	120
	1DW	No. 1 Poplin	30,60,90,120	None	120	None	120
	1DX	" " "	30,60,90,120	None	120	None	120
	1DY	" " "	30,60,90,120	1 small area upper back	90	(Note 1)	120
	1DZ	" " "	30,60,90,120	None	120	None	120
	4DW	No. 4 Poplin	30,60,90,120	None	120	None	120
	4DX	" " "	30,60,90,120	None	120	None	120
	4DY	" " "	30,60,90,120	None	120	None	120
	4DZ	" " "	30,60,90,120	None	120	None	120
	7DX	No. 7 Gabardine	30,60,90,120	None	120	None	120
	7DY	" " "	30,60,90,120	None	120	None	120
	7DZ	" " "	30,60,90,120	3 small areas upper back	60	1 very large area upper back	120
	6DX	No. 6 Twill	15,30	1 small area upper back	15	Entire upper back	30
	6DY	" " "	30,60	2 large areas upper back	30	Entire upper and lower back	60
	6DZ	" " "	15,30,60	3 small areas upper back	15	Entire upper back and 1 small area lower front	60
	5DY	No. 5 Poplin	30	Entire upper back and 2 very large areas lower front	30	Entire upper back and 2 very large areas lower front	30
	5DZ	" " "	15,30	2 small areas upper back and 2 large areas lower front (at knees)	15	1 very large area upper back and 2 large areas lower front (at knees)	30
Single-Thickness	3Z	No. 3 Oxford	15,30,45,60,75,90,105,120	Fine spray over upper back	120	(Note 2)	120
	2Z	No. 2 Sateen	15,30,45,60,75,90	2 large areas upper back	75	1 very large area and 1 large area upper back	90
	1Z	No. 1 Poplin	15,30,45,60,75	2 small areas upper back	45	2 large areas upper back and 3 large areas lower front	75
	4Z	No. 4 Poplin	15	2 large areas and 4 small areas upper back	15	2 large areas and 2 small areas upper back	15

Note 1

Serious wetting of the suitcoat was not noted at the end of the test (120 minutes). The single small wetted area noted at the 90 minute inspection period did not increase in area during the subsequent 30 minute exposure period.

Note 2

Serious wetting of the suitcoat was not noted at the end of the test (120 minutes). The fine spray over the upper back consisted of very fine droplets.

Rain Room. Consequently, the rayon in all of the remaining single-thickness coats was processed with the wax type repellent, before proceeding further.

The main program was carried out with simulated rains of 1 inch and 3 inch per hour intensity. It is realized that rains of such intensity, especially of 3 inch per hour intensity, do not normally continue for long periods. However, it is just such rains of short duration which cause most garment failures. In other words, the utility of a water-repellent raincoat is primarily dependent on the intensity of the rain which it will withstand without leakage or penetration. A garment which would fail quickly in a summer thundershower is of limited value, even though it might be capable of withstanding a light rain for a long period. A technical discussion of rain is beyond the scope of this paper. However, it can be stated that rains of 1 inch per hour intensity can be classified as "heavy," and that 3 inch per hour rains correspond to the "cloudbursts" or thunder-showers which often occur for short periods in the summer, late in the afternoon in the Delaware-South Jersey area, just as the authors are returning home from work.

Fifty-five raincoats were evaluated in the main program. Some were exposed in a 1 inch per hour rain and some were exposed in a 3 inch per hour rain as follows:

1 inch per hour rain

3 single-thickness coats, No. 1, Poplin
3 single-thickness coats, No. 2, Sateen
3 single-thickness coats, No. 3, Oxford
3 single-thickness coats, No. 4, Poplin
4 single-thickness coats, No. 5, Poplin
4 single-thickness coats, No. 6, Twill
4 single-thickness coats, No. 7, Gabardine
1 double-thickness coat, No. 5, Poplin
1 double-thickness coat, No. 6, Twill
1 double-thickness coat, No. 7, Gabardine

3 inch per hour rain

4 double-thickness coats, No. 1, Poplin
4 double-thickness coats, No. 2, Sateen
4 double-thickness coats, No. 3, Oxford
4 double-thickness coats, No. 4, Poplin
2 double-thickness coats, No. 5, Poplin
3 double-thickness coats, No. 6, Twill
3 double-thickness coats, No. 7, Gabardine
1 single-thickness coat, No. 1, Poplin
1 single-thickness coat, No. 2, Sateen
1 single-thickness coat, No. 3, Oxford
1 single-thickness coat, No. 4, Poplin

The foregoing distribution of the raincoats between the rains of two intensities was made upon the basis of the rough ranking obtained in the preliminary work. It can be seen that, in the 1 inch per hour rain, all seven of the test fabrics were evaluated as single-thickness garments, and the four best as single-thickness garments in the 3 inch per hour rain. In the 3 inch per hour rain, all seven of the fabrics were evaluated as double-thickness raincoats, and the three poorest fabrics were evaluated as double-thickness raincoats in the 1 inch per hour rain.

The garments were worn by different individuals while engaging in a normal walk in the rain area of the Rain Room. The garments were distributed among the group of wearers so that no single individual wore more than one coat of each kind. For example, the four double-thickness raincoats made of fabric No. 4 which were evaluated in the 3 inch per hour rain were distributed among four different wearers. This was done in order to average or equalize the effects which personal characteristics of the wearers might have on the performance of the garments. Each individual wearer wore under the raincoat his own suitcoat, shirt, and undershirt. The suitcoats were of different materials. Consequently, they varied in resiliency and absorption characteristics. This variation was deliberately planned in order to average the effects which the supporting surfaces might have on the performance of the raincoats.

Each raincoat was worn until serious penetration occurred or until a total wearing time of two hours had elapsed. Serious penetration for the purpose of this work was a penetration through the raincoat sufficient to produce: (a) wetting of the suitcoat over an area or areas approximating a total of 50 square inches, or (b) wetting of the suitcoat to the extent of 30 or more grams.

During the exposure period the wearers left the rain area at planned intervals for inspection. At such times the raincoat was removed and any wetting of the suitcoat was determined by observation or weighing. The results were recorded on a standard chart. In the case of the double-thickness coats, any penetration through the first layer only also was recorded. Penetration through the seams was not taken into account in evaluating the garments. In other words, this work was concerned with fabric performance, and was not concerned with the properties of any particular garment design or seam construction.

Table II shows the complete data obtained with the raincoats in the 1 inch per hour rain. Table III shows the complete data obtained in the 3 inch per hour rain.

Fabric Evaluation with Laboratory Penetration Tests

1. Rain Test

In Table IV are given complete data obtained on the seven test fabrics with the Rain Tester, using the standard method described previously. Data on both single and double thicknesses of the fabrics are shown. The values given are grams penetration (or grams absorbed by the blotter behind the test fabric or fabrics) during a 5-minute test period. In the case of the double-thickness tests, the water which penetrated through the first thickness but not through the second was neglected. (The same procedure was followed in running double-thickness tests with the Bundesmann, Drop-Penetration and Hydrostatic Pressure testers). Tests were made on each fabric, or combination, with various pressure heads between 2 and 8 feet on the nozzle in order to show: (a)

TABLE IV

Rain Test Data—Penetrations in 5-Minute Test Period

Fabric Identification	Number of Thicknesses Tested	Average Penetration with Indicated Pressure Head on Nozzle—grams						
		2 feet	3 feet	4 feet	5 feet	6 feet	7 feet	8 feet
No. 3, Oxford	1	0	0	0.1	—	—	—	0.5
No. 2, Sateen	1	0.1	0.3	0.9	0.7	7.9	9.0	13.8
No. 1, Poplin	1	0.2	0.8	2.8	6.5	14.4		
No. 4, Poplin	1	2.2	7.6	14.1				
No. 7, Gabardine	1	11.7						
No. 6, Twill	1	12.7						
No. 5, Poplin	1	13.0						
No. 3, Oxford	2	—	—	—	—	—	—	0
No. 2, Sateen	2	—	—	—	—	—	—	0
No. 1, Poplin	2	—	—	—	0	0.1	0.1	0.3
No. 4, Poplin	2	—	—	0	0.1	0.3	0.5	3.0
No. 7, Gabardine	2	—	—	0	0.3	0.7	0.6	3.0
No. 6, Twill	2	—	0	3.6	13.8			
No. 5, Poplin	2	0.5	3.1	14.6				

TABLE V

Rain Test Data—Time to Start Penetration and Time for 4 Grams Penetration Using a Fixed Pressure Head of 3 Feet on the Nozzle

Farbic Identification	Number of Thicknesses Tested	Average Time for Initial Penetration—seconds	Average Time for 4 Grams Penetration—seconds
No. 3, Oxford	1	930	3600*
No. 2, Sateen	1	116	3600†
No. 1, Poplin	1	20	1500
No. 4, Poplin	1	8	120
No. 7, Gabardine	1	1	14
No. 6, Twill	1	1	4
No. 5, Poplin	1	1	2
No. 6, Twill	2	305	1420
No. 5, Poplin	2	8	180

* Less than 0.1 grams penetration at end of test (3600 seconds or 1 hour).
† Average of 3.5 grams leakage at end of test (3600 seconds or 1 hour).

the maximum head at which no leakage occurred, (b) the change in leakage with increasing heads and (c) the minimum head required to cause "breakdown," or penetration of more than 10 grams of water. In the table the single-thickness fabrics are listed in order of decreasing resistance to penetration. The same thing is done with the fabrics in double thickness. It will be noted that the two relative rankings are the same.

In Table V are given data obtained with the Rain Tester, using an auxiliary procedure. The samples were mounted in the standard manner, but a single pressure head of 3 feet was used. The back of the fabric holder was of transparent plastic so that penetration through to the blotter behind the fabric could be observed. The test was run until complete wetting of the blotter occurred (equivalent to the absorption of approximately 15 grams of water). Determinations were made of: (a) the time corresponding to initial wetting of the blotter, and (b) the time corresponding to 4 grams wetting of the blotter. The latter figure was obtained by interrupting the test at intervals, noting the time, and weighing the blotter. The data then were plotted and the time for 4 grams wetting taken from the curve.

The auxiliary procedure is analogous to that used with the Drop-Penetration Tester, in that the time for an arbitrary degree of penetration is determined. (The authors believe that it does not give as complete an over-all picture of the penetration resistance of a fabric as the conventional Rain Test procedure. However, it is convenient for use when the number of available test specimens does not permit a complete evaluation. It also is of aid in testing fabrics of very high resistance, or those with swelling or closing characteristics, which show little or no leakage in 5 minutes at the maximum pressure head obtainable with the Rain Tester—see Table IV.)

2. Bundesmann, Drop-Penetration, Hydrostatic Pressure and Impact Penetration Tests.

In Table VI are given data obtained on the seven test fabrics with the four penetration testers previously described in the literature: the Bundesmann[12, 13], Drop-Penetration[5, 15], Impact Penetration[15, 16], and Hydrostatic Pressure [9, 14] testers. With each instrument, the specified procedure previously described was used. Both single and double thicknesses of the fabrics were tested, except in the case of the Impact Penetration Test. That test is not sufficiently severe to evaluate double thicknesses of the ordinary rainwear fabrics.

The values given for the Bundesmann Test are volumes of water penetration in cubic centimeters during a 20-minute test period. The values for the Drop-Penetration Test are times in minutes required for a 10 cubic centimeter volume of water penetration. The values for the Impact Penetration Test are water penetrations in grams, or grams of water absorbed by the blotter beneath the fabric during the running of the test. The values for the Hydrostatic Pressure Test are water pressure heads in centimeters required to start leakage through the test fabric at three separate points.

It will be noted that Drop-Penetration Test times of 60+ minutes are shown for the No. 2 Sateen and No. 3 Oxford in double thickness. It was concluded that those two fabric combinations were beyond the range of the instrument. It would be impractical from a time standpoint to use a testing interval of more than 60 minutes on any one specimen of a fabric or fabric combination, since multiple specimens must be tested in order to obtain reliable average values.

A difficulty with the Bundesmann instrument was encountered which might prove serious in routine or general testing work. The drop-forming device comprises 304 brass jets of extremely small diameter (0.4 millimeters or 0.0157 inches). During the running of the tests reported here, many of the jets became clogged even through distilled and filtered water was used. Consequently, it was necessary to interrupt the work at frequent intervals to clean the jets. This

TABLE VI

Bundesmann, Drop-Penetration, Impact Penetration, and Hydrostatic Pressure Test Data

Fabric Identification	Number of Thicknesses Tested	Average Bundesmann Test Penetrations—cubic centimeters/20 minutes*	Average Drop-Penetration Test Times—minutes	Average Hydrostatic Pressure Test Readings—centimeters†	Average Impact Penetration Test Penetrations—grams
No. 3, Oxford	1	0	54	72	0
No. 2, Sateen	1	0.2	8.8	43	0
No. 1, Poplin	1	1.8	3.7	42	<0.1
No. 4, Poplin	1	3.9	3.2	37	<0.1
No. 7, Gabardine	1	20	1.3	26	1.1
No. 6, Twill	1	59	0.77	27	1.6
No. 5, Poplin	1	99	0.72	19	11.4
No. 3, Oxford	2	0	60+	97	
No. 2, Sateen	2	0	60+	55	
No. 1, Poplin	2	0	22	52	
No. 4, Poplin	2	0.2	22	46	
No. 7, Gabardine	2	<0.1	8.8	29	
No. 6, Twill	2	0.3	1.7	29	
No. 5, Poplin	2	3.0	1.1	21	

* The Bundesmann Test was run for 20 minutes instead of the specified time of 10 minutes. This was done in an effort to obtain measurable penetrations on all of the fabrics in single thicknesses. However, even with the 20-minute time the penetration for one thickness of No. 3 Oxford was zero and the penetration for one thickness of No. 2 Sateen was only 0.2 cubic centimeters. When the time was further increased to 60 minutes, the observed penetrations were only 0.1 cubic centimeter on additional samples of both the sateen and oxford in single thickness.

The tabulated 20-minute Bundesmann Test data indicate that No. 4 Poplin is definitely superior to No. 7 Gabardine in single thickness, but slightly inferior in double thickness. Additional tests, made with a time of 60 minutes, confirmed the relative inferiority of No. 4 Poplin in double thickness; two thicknesses of No. 4 Poplin allowing a penetration of 19 cubic centimeters and two thicknesses of No. 7 Gabardine allowing a penetration of only 2.6 cubic centimeters.

† The Hydrostatic Pressure Test was run with a rate of increase of head of one centimeter per second, as specified in the 1945 A.A.T.C.C. Year Book. As an experiment, No. 3 Oxford also was tested with an increase of head of 0.5 centimeters per second. A single thickness of the fabric gave an average reading of 71 centimeters, while two thicknesses of the fabric gave an average reading of 97 centimeters.

TABLE VII

Summarized Rain Room Data from Tables II and III

Type Raincoat	Average Penetration Time in Rain Room—minutes			
	1 Inch/Hour Rain		3 Inch/Hour Rain	
	Start	Breakdown	Start	Breakdown
Single-Thickness No. 3, Oxford	110	120+	120	120+
Single-Thickness No. 2, Sateen	90	100	70	90
Single-Thickness No. 1, Poplin	45	80	45	75
Single-Thickness No. 4, Poplin	25	60	<15	15
Single-Thickness No. 7, Gabardine	5	25	..	..
Single-Thickness No. 6, Twill	5	20	..	..
Single-Thickness No. 5, Poplin	<5	10	..	..
Double-Thickness No. 3, Oxford	..	..	120+	120+
Double-Thickness No. 2, Sateen	..	..	120+	120+
Double-Thickness No. 1, Poplin	..	..	120+	120+
Double-Thickness No. 4, Poplin	..	..	120+	120+
Double-Thickness No. 7, Gabardine	120+	120+	100	120+
Double-Thickness No. 6, Twill	120+	120+	15	45
Double-Thickness No. 5, Poplin	120+	120+	15	<30

disadvantage of the Bundesmann instrument has been referred to by other investigators[21]. The Drop-Penetration instrument gave no trouble from clogging during the work reported here. However, unless care is exercised that instrument might also give trouble from clogging, since the inside diameter of its capillaries or jets is the same as that of the Bundesmann instrument.

ANALYSIS OF EXPERIMENTAL DATA

Rain Room Data

In Table VII are given summarized Rain Room data that were obtained by a careful consideration of the time and nature of penetration of each test raincoat described in detail in Tables II and III.

The summarized single-thickness results in Table VII show a definite relative ranking of the garments according to the time required to start leakage and the "breakdown," or time to cause serious penetration. The best type raincoat (made of fabric No. 3) did not fail in a 2-hour exposure in the 1 inch per hour rain, and the poorest type (made of fabric No. 5) failed in 10 minutes. This same relative ranking was obtained on the single-thickness garments that were tested in the 3 inch per hour rain. It is believed that the three poorest single-thickness types (made of fabrics No. 5, No. 6 and No. 7) would be of limited value for rainwear purposes since they started to fail in 5 minutes or less in the 1 inch per hour rain, and failed completely in 25 minutes or less.

It should be noted that the double-thickness raincoats gave much greater protection than the corresponding single-thickness garments. The magnitude of the improvement is extremely surprising in most cases. For example, the single-thickness type made of fabric No. 5 failed seriously in 10 minutes in the 1 inch per hour simulated rain, while the double-thickness type made of the same fabric did not permit any leakage in 120 minutes. Likewise, the single-thickness type made of fabric No. 4 failed seriously in 15 minutes in the 3 inch per hour rain, while the double-thickness type made of the same fabric did not permit any leakage in 120 minutes.

This improvement produced by fabric doubling suggests the use of multiple plies of light fabrics to achieve rain resistance equal to that afforded by single layers of relatively heavy, closely-woven fabrics. It was first investigated in early work with the Rain Tester[8], and later confirmed by Sookne[20].

Perhaps the most striking point illustrated by the Rain Room data is the influence of rain intensity on garment performance. When the single-thickness and double-thickness garments listed in Table VII are considered together as one group, it will be observed that they are ranked in a different order of performance in the 1 inch per hour rain than in the 3 inch per hour rain. For example, the double-thickness raincoats made of fabrics No. 6 and No. 5 were superior to the single-thickness raincoats made of fabrics No. 2 and No. 1 in the 1 inch per hour rain, but inferior to those two single-thickness raincoats in the 3 inch per hour rain. As noted previously, such reversals in order are not observed when *only* the single-thickness garments are considered together as one group. However, an increase in rain intensity affected the different single-thickness garments differently. For example, the single-thickness garments made of fabrics No. 2 and No. 1 were affected only slightly by increased intensity of rain, while the penetration resistance of the single-thickness garments made of fabric No. 4 decreased markedly when the rain intensity was increased. The following data, rearranged from Table VII, show these points clearly:

	Time for Serious Penetration	
Double-Thickness	1 inch/hour	3 inch/hour
No. 6, Twill ..	120+ min.	45 min.
No. 5, Poplin ..	120+	<30
Single-Thickness		
No. 2, Sateen ..	100	90
No. 1, Poplin ..	80	75
No. 4, Poplin ..	60	15

Laboratory Penetration Data

The data of Tables IV, V, VI and VII indicate, in general, that the various testers line up the single-thickness fabrics in the same order as the Rain Room. The double-thickness results are less obvious, because the data do not, in every case, show clear-cut differences between some of the fabric combinations.

In the following sections, the data developed by means of the five laboratory penetration tests are considered on the basis of the points illustrated by the Rain Room work, namely:

The relative ranking of the raincoats.

The improvement effected by fabric doubling.

The effects of variations in rain intensity.

1. Rain Test

The Rain Test is a relatively severe test suitable for the evaluation of fabrics, and fabric combinations, possessing good as well as moderate rain resistance. The use of different spray intensities allows the rapid determination of penetration resistance over a wide range, as well as the development of data indicative of performance under various intensities of rain. In addition, variations in testing technique (such as determining the penetration time at a single intensity) allow the use of the Rain Test for detecting differences in performance between fabrics of high penetration resistance.

The Rain Test evaluations on the single-thickness fabrics, given in Table IV, rank the fabrics in the same order as does the Rain Room. This correlation is confirmed by the double-thickness data.

The magnitude of the improvement effected by fabric doubling may be seen both from the conventional Rain Test data shown in Table IV and from that developed by use of the modified test and shown in Table V.

Table VIII shows Rain Test and Rain Room data rearranged from Tables IV and VII. It shows, listed together in the order of their Rain Test performance, the eleven best fabrics and fabric combinations. (Single-thickness data on fabrics No. 5, No. 6 and No. 7 are omitted).

The Rain Test data in Table VIII show significant differences between all of the fabrics and fabric combinations, except between Nos. 3 and 2, double thickness. In other words, the eleven best fabrics and fabric combinations are divided into ten categories of penetration resistance by the Rain Test. It should also be noted that the Rain Test, in 5-minute test periods, gave serious leakage with all of the fabrics and combinations that broke in the Rain Room in 2-hour exposures.

TABLE VIII
Average Rain Test and Rain Room Data from Tables IV and VII

	Rain Test							Rain Room	
	Penetration in 5 Minutes at Indicated Head—grams							Time for Serious Penetration—minutes	
	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.	1 Inch/Hour	3 Inches/Hour
Double-Thickness No. 3, Oxford	..	..	..	..	..	..	0	..	120+
Double-Thickness No. 2, Sateen	..	..	..	..	..	..	0	..	120+
Double-Thickness No. 1, Poplin	..	..	..	0	0.1	0.1	0.3	..	129+
Single-Thickness No. 3, Oxford	0	0	0.1	..	..	..	0.5	120+	120+
Double-Thickness No. 4, Poplin	..	..	0	0.1	0.3	0.5	3.0	..	120+
Double-Thickness No. 7, Gabardine	..	..	0	0.3	0.7	0.6	3.0	120+	120+
Single-Thickness No. 2, Sateen	0.1	0.3	0.9	0.7	7.9	9.0	13.8	100	90
Single-Thickness No. 1, Poplin	0.2	0.8	2.8	6.5	14.4			80	75
Double-Thickness No. 6, Twill	..	0	3.6	13.8				120+	45
Double-Thickness No. 5, Poplin	0.5	3.1	14.0					120+	<30
Single-Thickness No. 4, Poplin	2.2	7.6	14.1					60	15

Table VIII also shows that the Rain Test ranked the eleven best fabrics and combinations in the same order as did the 3 inch per hour rain, which none of the other tests accomplished, as will be pointed out in the following sections. In the 1 inch per hour rain, however, the positions of double thicknesses of fabrics No. 6 and No. 5 do not agree with the ranking established by the Rain Test. The reason for this is illustrated by the following Rain Test data rearranged from Table IV:

	Penetration in 5-Minute Test—grams				
	2 feet	3 feet	4 feet	5 feet	6 feet
No.					
2 Single	0.1	0.3	0.9	0.7	7.9
1 Single	0.2	0.8	2.8	6.5	14.4
6 Double	..	0	3.6	13.8	
5 Double	0.5	3.1	14.6		

The foregoing data show that fabric No. 6 in double thickness is inferior to fabrics No. 2 and No. 1 in single thickness at a pressure head of 4 feet, but superior at 2 and 3 feet. This reversal at low intensity is borne out by the reversal at low intensity rain in the Rain Room (see Table VII). A somewhat similar comparison may be drawn between fabric No. 5 in double thickness, and fabrics No. 2 and No. 1 in single thickness; the former is much inferior at a 4-foot head and only very slightly inferior at 2 feet.

2. *Bundesmann Test*

The Bundesmann Test is a relatively mild test which does not show differences between fabrics of high penetration resistance. As stated previously, the exposure time was increased from the recommended 10-minute time to 20 minutes in an attempt to evaluate the fabrics under consideration more adequately.

From Tables VI and VII it may be seen that the Bundesmann Test ranked the single-thickness fabrics in the same order as the Rain Room. Five of the fabrics in single thickness allowed the passage of appreciable quantities of water in the test, but three of those fabrics (Nos. 5, 6 and 7) are of limited suitability for rainwear.

TABLE IX
Average Bundesmann Test and Rain Room Data from Tables VI and VII

	Bundesman Test	Rain Room Time for Serious Penetration—minutes	
	Penetration in 20 Minutes—cc.	1 Inch/Hour	3 Inches/Hour
Double-Thickness No. 3, Oxford	0	..	120+
Double-Thickness No. 2, Sateen	0	..	120+
Double-Thickness No. 1, Poplin	0	..	120+
Single-Thickness No. 3, Oxford	0	120+	120+
Double-Thickness No. 7, Gabardine	<0.1	120+	120+
Double-Thickness No. 4, Poplin	0.2	..	120+
Single-Thickness No. 2, Sateen	0.2	100	90
Double-Thickness No. 6, Twill	0.3	120+	45
Single-Thickness No. 1, Poplin	1.8	80	75
Double-Thickness No. 5, Poplin	3.0	120+	<30
Single-Thickness No. 4, Poplin	3.9	60	15

On the double-thickness fabrics, the Bundesmann Test caused the penetration of an appreciable amount of water only in the case of the poorest fabric (No. 5), which possesses only limited rain resistance. However, the Bundesmann data show that penetration resistance is markedly improved by fabric doubling.

Table IX shows Bundesmann Test and Rain Room data rearranged from Tables VI and VII. It shows, listed together in the order of their Bundesmann Test performance, the eleven best fabrics and fabric combinations. (Single-thickness data on fabrics No. 5, No. 6 and No. 7 are again omitted.)

In Table IX, it was actually not possible to rank the first four fabrics or fabric combinations since they allowed no penetration in the 20-minute Bundesmann Test. It can be seen that the Bundesmann data divide the eleven satisfactory fabrics or fabric combinations into only seven categories of slightly different penetration resistance. Over the entire range, representing Rain Room times of 15 minutes to 2 hours, the Bundesmann data range only from 0 to 3.9 cc.

It will also be noted that the Bundesmann Test did not rank the eleven best fabrics and combinations in the same order as did either the 1 inch per hour rain or the 3 inch per hour rain. Since this test is run at a single intensity, it does not provide data indicative of the effects of varying rain intensity.

3. *Drop-Penetration Test*

The Drop-Penetration Test is a more severe test than the Bundesmann Test and may be used over a wider range of penetration resistance. However, it should be pointed out that a long test period is required to obtain several determinations on a fabric of relatively high penetration resistance.

From Tables VI and VII, it will be noted that the Drop-Penetration Test correlates well with the Rain Room on the single-thickness fabrics in the 1 inch per hour rain. This correlation is confirmed by the double-thickness data.

The Drop-Penetration Test results indicated the magnitude of penetration resistance improvement effected by fabric doubling, with the exception of the poorest two fabrics (Nos. 6 and 5).

Table X shows Drop-Penetration Test and Rain Room data, rearranged from Tables VI and VII. In this instance, the eleven best fabrics and fabric combinations are listed together in the order of their Drop-Penetration Test performance.

The data in Table X show that the Drop-Penetration Test divided the eleven best fabrics and combinations into eight categories of penetration resistance.

It can also be seen that the Drop-Penetration Test, like the Bundesmann Test, did not rank the eleven best fabrics and combinations in the same order of superiority as did either the 1 inch per

TABLE X

Average Drop-Penetration Test and Rain Room Data from Tables VI and VII

	Drop-Penetration Test	Rain Room Time for Serious Penetration—minutes	
	Time for 10 cc. Leakage—minutes	1 Inch/Hour	3 Inches/Hour
Double-Thickness No. 3, Oxford	60+	..	120+
Double-Thickness No. 2, Sateen	60+	..	120+
Single-Thickness No. 3, Oxford	54	120+	120+
Double-Thickness No. 1, Poplin	22	..	120+
Double-Thickness No. 4, Poplin	22	..	120+
Double-Thickness No. 7, Gabardine	8.8	120+	120+
Single-Thickness No. 2, Sateen	8.8	100	90
Single-Thickness No. 1, Poplin	3.7	80	75
Single-Thickness No. 4, Poplin	3.2	60	15
Double-Thickness No. 6, Twill	1.7	120+	45
Double-Thickness No. 5, Poplin	1.1	120+	<30

hour or the 3 inch per hour simulated rain. For example, the Drop-Penetration Test ranked a single-thickness of fabric No. 4 above a double-thickness of fabric No. 5, while a reverse ranking was obtained in both the 1 inch and 3 inch per hour rains.

It is not possible to interpret the effects of varying rain intensity by means of the Drop-Penetration Test data since this test also exposes the fabrics to the impact of drops of water at a single intensity.

4. Hydrostatic Pressure Test

The Hydrostatic Pressure Test subjects fabrics to gradually increasing water pressures and not to the impact of water in motion. Consequently, as pointed out by numerous observers, it does not lend itself to development of data indicative of the rain resistance of water-repellent fabrics.

Because of the wide differences in penetration resistance of the fabrics selected for this work, the Hydrostatic Pressure Test ranked the single-thickness fabrics in roughly the same order as does the Rain Room. This correlation is confirmed by the double-thickness data. However, the data show little or no difference between some fabrics (as, for example, between fabrics No. 2 and No. 1 in single thickness) that differed markedly in Rain Room performance.

The Hydrostatic Pressure Test gives little or no indication of the magnitude of the improvement effected in performance by doubling a fabric. This would be expected by the nature of the test. When the first fabric of a combination fails, the water pressure becomes the same on both sides of that fabric. The second fabric then fails as soon as enough water has passed through the first fabric to fill the space between the two. This, of course, causes a slight time lag with an attendant slightly higher reading for the combination.

Table XI shows Hydrostatic Pressure Test and Rain Room data, rearranged from Tables VI and VII. In this instance, the eleven best fabrics and fabric combinations are listed together in the order of their Hydrostatic Pressure Test performance.

The data in Table XI show that the Hydrostatic Pressure Test divided the eleven fabrics and combinations into ten categories of penetration resistance. However, the test shows only minor differences in some cases between fabrics or combinations which differed markedly in the Rain Room tests. Definite reversals are shown, as, for example, on fabric No. 7 in double thickness, which was inferior to fabric No. 4 in single thickness in the Hydrostatic Pressure Test but superior to that fabric in the Rain Room.

The Hydrostatic Pressure Test, like the Bundesmann Test and the Drop-Penetration Test, did not rank the eleven best fabrics and combinations in the same order as did either the 1 inch per hour or the 3 inch per hour rain. This test also gives no indication of variations in performance under varying intensities of rain.

5. Impact Penetration Test

The Impact Penetration Test is a relatively mild test which does not show differences between fabrics of high penetration resistance.

The data given in Tables VI and VII show that the Impact Penetration Test ranked the single-thickness fabrics in the same general order as did the Rain Room.

The lack of severity of the Impact Penetration Test prevented the compilation of data on the effect of fabric doubling. Since this test employs only one intensity of water delivery, it does not show performance variations that occur in different intensities of rain.

CONCLUSIONS

Of the five laboratory penetration testers studied, the Rain Tester appears to be the most versatile. The Rain Room data indicated that the relative performances of a series of water-repellent raincoats may change as the rain intensity varies. The laboratory Rain Tester subjects fabrics to different intensities of water impact, and thus furnishes an over-all picture of probable performance.

The Bundesmann and Drop-Penetration testers employ water drops impinging on the test fabric with a single intensity, and thus do not take into account the fact that natural rains vary in intensity. The Hydrostatic Pressure Tester does not simulate the dynamic effects of rain, and, therefore, could not be expected to indicate the probable rain performance of garments in general.

The Impact Penetration Tester employs a single intensity of water impact, and thus suffers from the same fault as the Bundesmann and Drop-Penetration testers. However, the authors believe that the Impact Penetration Test, because of its simplicity and ease of operation, is suitable for ruling out fabrics which are of limited value for use in water-repellent rainwear. For example, the four fabrics in this study which gave reasonable performance as single-thickness garments gave penetration values of less than 0.1 gram in the Impact Penetration Test. The three fabrics which gave poor performance as single-thickness garments, even in a 1 inch per hour simulated rain, all gave penetrations of more than 1.0 gram in that laboratory test.

TABLE XI

Average Hydrostatic Pressure Test and Rain Room Data from Tables VI and VII

	Hydrostatic Pressure Test—cm.	Rain Room Time for Serious Penetration—minutes	
		1 Inch/Hour	3 Inches/Hour
Double-Thickness No. 3, Oxford	97	..	120+
Single-Thickness No. 3, Oxford	72	120+	120+
Double-Thickness No. 2, Sateen	55	..	120+
Double-Thickness No. 1, Poplin	52	..	120+
Double-Thickness No. 4, Poplin	46	..	120+
Single-Thickness No. 2, Sateen	43	100	90
Single-Thickness No. 1, Poplin	42	80	75
Single-Thickness No. 4, Poplin	37	60	15
Double-Thickness No. 7, Gabardine	29	120+	120+
Double-Thickness No. 6, Twill	29	120+	45
Double-Thickness No. 5, Poplin	21	120+	†30

A number of points concerning garment construction were observed during the Rain Room work. In the manufacture of rainwear, it is of great importance to use only water-repellent materials. The inclusion of absorbent thread or trimming fabrics results in a serious decrease of the protection afforded by a garment. The deleterious effect of an untreated viscose process rayon trimming fabric for the seams was discussed earlier. In addition, a few seams in some of the garments tested had been sewn with absorbent thread. Those seams permitted leakage much quicker than the remaining seams sewn with water-repellent thread.

The trouble caused by the viscose rayon trim on some of the seams illustrated some early work with the laboratory Rain Tester. In that work, it was found that the resistance of a layer of water-repellent fabric is influenced markedly by the repellency of the supporting surface[8,9]. Consequently, it is believed that all linings should either be omitted or rendered water repellent.

Doubling a fabric will markedly improve its performance. However, the garments tested showed that some consideration should be given to the single-thickness properties of fabrics to be used in double-thickness rainwear. The use of an inadequate outer shell will allow rain to pass through the first layer and into the pockets, for example. The double-thickness garments tested in this work used a double thickness only in the upper part and sleeves. In the case of those garments thus constructed with the poorer fabrics, water which penetrated through the first layer at the upper back ran down the inner fabric and wetted the wearer.

It is believed that the results obtained in this work should furnish a basis for evaluating one type of laboratory instrument against another, and for correlating the properties of laboratory instruments with those of rainfall. In addition, the data obtained should aid in interpreting a laboratory test result in terms understandable to the trade in general and to the consuming public. For example, a Rain Tester penetration of 2.8 grams at a 4-foot head, or a Drop-Penetration Tester reading of 3.7 minutes, means little or nothing to an individual contemplating the purchase of a water-repellent raincoat. But, he will know what is meant by a claim which expresses probable performance in terms of resistance to a light rain, heavy rain, or cloudburst.

It is also believed that the work reported here should be of interest to those groups interested in the promulgation of commercial standards, such as the Federal Trade Commission, the National Bureau of Standards, the Water-Repellent Fabrics Group[21,22] of the Textile Fabrics Association, the Mail Order Association of America, the American Standards Association, and the National Retail Dry Goods Association.

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Aircraft Textiles

(Concluded from Page P103)

to 10″ per minute. This may be due to a combination consisting of acetate dopes with one or more coats of nitrate dope, or the use of nitrate in mixing the pigments. Burn rates, such as these, are definitely too high and some effort toward reducing the same is necessary.

In this regard, if it can be proved that no nitrate exists in the present finish, no further consideration is necessary. This can be done by the use of an indicator, such as, diphenylamine, used in the following solution (Ref. Chart I, Table III, of the "Modern Plastics Encyclopedia" for 1945):

0.017 grams of diphenylamine dissolved in 30 m. l. H_2O and 100 m. l. of concentrated H_2SO_4.

It will be satisfactory to protect the sides of the fuselage from the floor to the bag shelf. It will not be necessary to change the bag shelf or the dome lining until such time as the cabin is normally relined. Soundproofing and other materials covered by the lining, need only meet the flash-resistant requirements.

Plywood cabin floors are acceptable, but the floor covering must be flame-resistant. Seat slip-on covers, if used during passenger flights, should be flame-resistant. Napkins or heat-rest linens need not be.

In sleeper planes, flame-proofing of bed linens is not required. Berths should be placarded against smoking. Wool blankets are acceptable without treatment.

Map cases presently installed need not be changed. Ash trays must be of the self-contained type. However, in some cases built-in ash trays are now used which are not completely removable. Continued use of these may be permitted if it can be demonstrated that they can be opened up for the purpose of extinguishing an internal fire.

The Civil Aeronautics Board has set May 1, 1947, as the starting date for activation of these regulations. This means that the airline operators must expedite the testing and installation of materials which are satisfactory and available. It is important that any manufacturers who have products which can pass the Civil Aeronautics Administration tests, should so inform the airline operators. A list of the personnel in each airline to whom such information should be addressed may be obtained by letter request to James R. Redmond, Chairman, AATCC Fire Resistance Committee, Interchemical Corporation, P. O. Box 1275, Providence, Rhode Island.

The publication of the C. A. A. statements and tests in the American Dyestuff Reporter must not be interpreted as indicating that the AATCC concurs in any of the above statements and tests. It simply emphasizes the urgency of the airline needs for assistance in the procurement of fire-resistant textiles. The readers of the American Dyestuff Reporter will note that the C. A. A. Test for flame resistance does not agree with the AATCC test for fire-resistant textiles and the C. A. A. test for flash resistance does not agree with the AATCC test for flammable textiles. The AATCC Committee on Testing Fire Resistant Materials is studying the C. A. A. tests in an effort to coordinate them with the AATCC tests. A report on this activity will be forthcoming in the near future.

Studies on Wool Dyeing: Crocking

(The following references were unintentionally omitted from the publication of the above named article by Millson, Watkins and Royer which appeared in our issue of February 10, 1947.)

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March 21st Meeting of NNE Section

THE next meeting of the Northern New England Section will be held on March 21st at the Hotel Manger, Boston, Mass. There will be a symposium on "Problems and Experiences in the Textile Industry." It will consist of six ten-minute papers by the following speakers:

Everett C. Atwell, Director of Research Laboratory, Textron, Inc., Lowell, Mass.: "A Short Resume of Special Scouring and Bleaching Methods for Rayon and Cotton."

Arthur F. Gallagher, Chief Chemist, Hayward Schuster Woolen Mills, Inc., East Douglas, Mass.; "A Little Trouble with White Effect."

Ralph E. Hale, Chief Chemist, Bell Company, Worcester, Mass.: "A Method for Recording the Streng'h of Scouring Solution in Continuous Cloth Scouring."

Alex. Morrison, Chief Chemist, American Woolen Company, Lawrence, Mass.: "A Study on Manipulated Blends."

Frank J. O'Neil, Director of Physical Research, Pacific Mills, Worsted Division, Lawrence, Mass.: "A Problem in Color Matching."

Fred. A. Prisley, Director of Research, Watson-Park Co., Andover, Mass.: "A Short Method for Control of Finished Weight."

There are to be no discussions between papers and no questions openly in the meeting.

All members are cordially invited by the Textile Chemical Dept., Monsanto Chemical Co., to visit their new laboratory on Friday, March 21st, at the Merrimac Chemical Plant, Everett, Mass., one block from Everett Station.

January Meeting, New York Section

THE last meeting of the New York Section was held on January 31st at the Swiss Chalet, Rochelle Park, New Jersey. A dinner preceded the meeting.

Patrick J. Kennedy, Chairman of the Nominating Committee, presented the name of Winn W. Chase as candidate for Councilor representing the New York Section. Mr. Chase was duly elected.

Henry F. Herrmann, President of AATCC, spoke briefly on the Association, emphasizing the importance of the individual member in evaluating the society as a whole. (Mr. Herrmann's remarks are published in this issue.)

The Chairman, Dr. Herman E. Hager, announced that the membership of the Section would be canvassed regarding choice of location for future meetings.

The first paper on the technical program was presented by George A. Slowinske, Head of the Fine Chemicals Sales Service of the duPont Company. Mr. Slowinske's subject was: "New Laboratory Test Method Accurately Predicts Rain Resistance of Outerwear."

The second paper was presented by Waldemar R. Kuenzel, Executive Manager, Fabric Development Dept., Deering Milliken & Co. His subject was: "Planned Textiles Promise New Era."

The attendance was 325.

Respectfully submitted,
NORMAN A. JOHNSON,
Secretary.

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Membership Applications

STUDENT

Emery G. Maynard—New Bedford Textile Institute. Sponsor: F. Tripp.

George D. Maynard, Jr.—New Bedford Textile Institute. Sponsor: F. Tripp.

John R. Motha—New Bedford Textile Institute. Sponsor: F. Tripp.

George E. Walker—New Bedford Textile Institute. Sponsor: F. Tripp.

Seymour Berman—Philadelphia Textile Institute. Sponsor: P. Theel.

Richard N. Combs—Philadelphia Textile Institute. Sponsor: P. Theel.

Alvin I. Garblik — Philadelphia Textile Institute. Sponsor: P. Theel.

Robert Hahn—Philadelphia Textile Institute. Sponsor: P. Theel.

Alan R. Liederman—Philadelphia Textile Institute. Sponsor: P. Theel.

Arthur Price—Philadelphia Textile Institute. Sponsor: P. Theel.

Thomas R. Scanlon, Jr.—Philadelphia Textile Institute. Sponsor: P. Theel.

Stephen R. Tomko—Philadelphia Textile Institute. Sponsor: P. Theel.

Jackson A. Burrell—Georgia School of Technology. Sponsor: C. A. Jones.

Ferrin Y. Mathews—Georgia School of Technology. Sponsor: C. A. Jones.

George Bedard—Bradford Durfee Technical Institute. Sponsor: L. B. Coombs.

Applications for Transfer to Senior Membership

C. F. Bishop, M. L. Blitz, H. A. Busby, R. H. Edgar, G. F. Goldstein, T. X. Johnidis, W. Mannheimer, D. Moss, J. W. Ross, M. L. Slesinger, W. E. Smith, J. D. Towery, A. Viola, R. J. Ziegler.

Future Meetings, NNE Section

THE Northern New England Section have announced the following program of meetings for the balance of 1947:

April 25—"Flame Proofing" by Ellicot Laboratories and Joseph Bancroft and Sons Co.

May 16—"Old Dyers, Old Books, and Old Methods, with Remarks on the History of Dyeing and Finishing" by Sidney M. Edelstein of Dexter Chemical Corp. This will be illustrated by old scientific books and manuscripts from Mr. Edelstein's extensive library.

June 13—Outing.

Sept. 17—"The Eye and its Ability to Detect Color" by Dr. Wald.

November 21 — "Detergents" by Dr. Harris, General Research Laboratory, Monsanto Chemical Co., Dayton, Ohio.

CALENDAR

EXECUTIVE COMMITTEE ON RESEARCH
Meeting: March 20. (Hotel Pennsylvania, New York)

NEW YORK SECTION
Meeting: May 2. (Swiss Chalet, Rochelle Park, N. J.)

RHODE ISLAND SECTION
Meetings: March 28, April 25.

PHILADELPHIA SECTION
Meetings: April 11, May 23.

NORTHERN NEW ENGLAND SECTION
Meetings: March 21, April 25, May 16, September 17, November 21.
Outing: June 13.

PIEDMONT SECTION
Meeting: April 12. (O. Henry Hotel, Greensboro, N. C.)

Outing: June 20 and 21. (Ocean Forest Hotel, Myrtle Beach, S. C.)

MID-WEST SECTION
Meeting: April 12. (Schroeder Hotel, Milwaukee, Wis.)

SOUTHEASTERN SECTION
Meeting: March 22. (Columbus, Ga.)
Meeting: June 7. (Atlanta, Ga.)

RESEARCH COMMITTEE
Sub-Committee Meetings: March 20. (Hotel Pennsylvania, New York.)
Meeting: March 21. (Hotel Pennsylvania, New York.)

COUNCIL
Meeting: March 21. (Hotel Pennsylvania, New York.)

NATIONAL CONVENTION
October 23, 24, 25. (Congress Hotel, Chicago, Ill.)

Improved Equipment and Methods for Fluidity Measurements of Cellulose and Cellulose Acetate

DOROTHY SIEGERT LYLE AND FRANCES KARR RAY
Ellen H. Richards Institute
The Pennsylvania State College

IN making fluidity measurements on cotton in the Ellen H. Richards Institute Laboratory at The Pennsylvania State College, Stubblebine (5) made certain modifications on existing methods, devising an end-over-end mixing machine for use with a series of viscometers of the pipette type; the pipettes served both as mixing devices and as viscosity instruments for measuring flow. These gave satisfactory results with new, laundered, and aged cotton fabrics. The method and instruments, however, were not found by the authors to yield consistent results with rayon.

Mease (3) published a report of an improved method for measuring apparent fluidity in a cuprammonium solution in which he introduced vials as mixing devices, and transferred the solution after mixing from the mixing vials to pipette viscometers.

This paper describes an improved mixing device for the dispersion of cellulose in cuprammanium solution and cellulose acetate in acetone. It describes also a constant temperature bath which will accommodate 20 mixing vials and seven pipette viscometers for measurement of cellulose in cuprammanium solution. The water bath is so constructed that it may be converted easily to accommodate seven Cannon-Fenske viscometers for making fluidity determinations of cellulose acetate rayon in acetone. The capacity of the water bath may be increased to meet the needs of a particular laboratory.

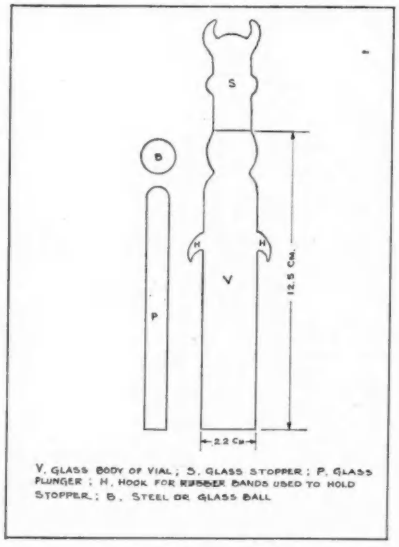
The apparatus for making fluidity measurements on cellulose dispersed in cuprammonium solution has the following characteristics: (a) the mixing vials are of the same general type as those used by Mease, although they are more easily constructed. They are made from materials which are readily available, and they have a sufficiently large capacity to permit two duplicate measurements to be made on the same solution; (b) the viscometers are of the pipette type used by numerous other investigators; and (c) a water-bath so constructed as to accommodate 20 mixing vials and seven pipette viscometers enables 40 measurements to be made daily, in contrast with smaller numbers of determinations in all techniques previously reported.

The apparatus for making fluidity measurements on cellulose acetate dissolved in acetone consists of the same mixing vials as those used for cellulose in cuprammonium solution, with the subsequent transfer of the solution to Cannon-Fenske viscometers. In all published reports on cellulose acetate fluidity determinations, the method of mixing was not specified. As compared with dissolving without agitation, use of the mixing vials was found to give a more uniform solution with less clogging of the capillaries after transfer to the viscometers. The viscometers also were handled in the same water bath as that used with the cellulose-cuprammonium dispersions. This was made possible by the removal of the glass cylinders and the insertion of seven of the more elaborate Cannon-Fenske viscometers into the wooden rack.

Methods for the construction of the apparatus and for making determinations are described as follows.

Construction of Mixing Vials

Equipment suitable for dispersing cellulose in cuprammonium solution and cellulose acetate in acetone is illustrated in Figure 1. The vial measures approximately 12.5 centimeters in length and 2.2 centimeters in diameter. It is fitted with a solid glass stopper and a glass plunger measuring approximately 10.2 centimeters in length and 1.0 centimeter in diameter. It is important that the vial and the plunger be so shaped that swollen cellulose will not adhere long to any part of the vial as it is rotated to effectuate mixing. In order to prevent any fibers from adhering to the neck of the vial, a glass ball, measuring nine-sixteenths of an inch in diameter, is introduced.



V, GLASS BODY OF VIAL; S, GLASS STOPPER; P, GLASS PLUNGER; H, HOOK FOR RUBBER BANDS USED TO HOLD STOPPER; B, STEEL OR GLASS BALL

Figure 1

Glass Mixing Vial for Use with Cellulose-Cuprammonium Dispersions or Cellulose Acetate Solutions in Acetone.

The glass stopper is constructed with two glass hooks at either side of the top, and the vial with two hooks at either side, similar to those on the mixing vial of Mease, so that rubber bands may hold the stopper in place during a mixing operation.

In order to determine the weight of cellulose necessary for each vial to give a solution of a definite concentration, the total volume of each vial, together with the glass rod and ball is determined according to the procedure used by Mease.

Preparation for Fluidity Measurements

To prepare a solution for fluidity measurements, the vial containing the plunger is half filled with the cuprammonium solution or the acetone, for cellulose or cellulose acetate, respectively; one or the other of the latter is added. When this is wetted with the liquid, more of the liquid is added until insertion of the ball and stopper displaces all of the air, with the vial entirely filled.

The stopper is held in place with rubber bands passing around the hooks, H, and the vial is attached to the wheel of the mixing apparatus.

Mixing Equipment

The equipment designed to facilitate the dispersion of cellulose in a cuprammonium solution or cellulose acetate in acetone consists chiefly of a copper-lined wooden trough with inside dimensions of 17 inches in length, seven and one-quarter inches in width, and six inches in depth. A copper-

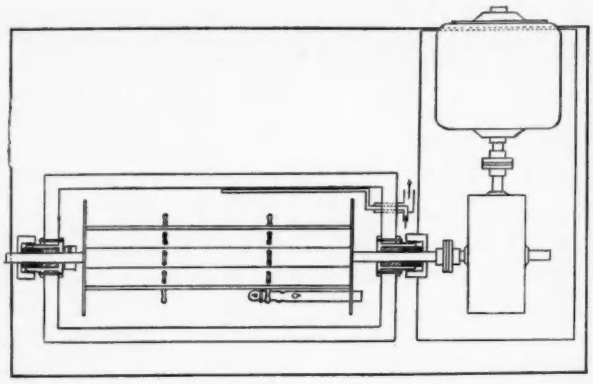


Figure 2

Structural Diagram of Mixing Equipment for the Dispersion of Cellulose in Cuprammonium Solution and Cellulose Acetate in Acetone.

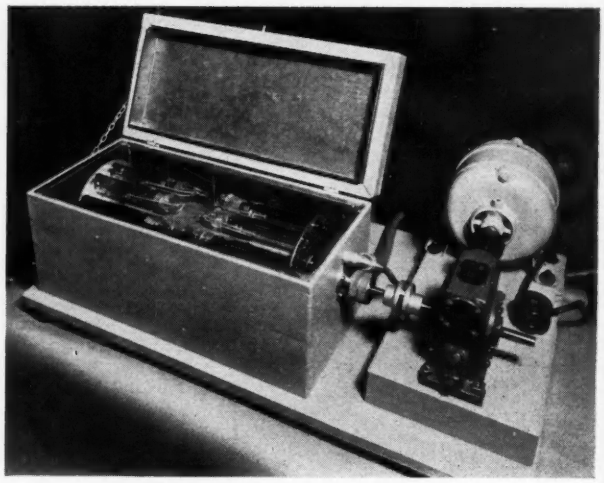


Figure 3

Photograph of Mixing Equipment for the Dispersion of Cellulose in Cuprammonium Solution and Cellulose Acetate in Acetone.

lined lid, flanged to extend one-fourth inch into the trough, protects the samples from light during the mixing period.

Inside the trough a brass decagon drum measuring 14 inches in length is mounted. At each end is mounted a brass disc measuring six inches in diameter. Ten holes measuring one inch in diameter are evenly spaced around the outer edge of the disc. These openings support the bottoms of the glass mixing vial, while stainless steel spring clips mounted on each section of the decagon, and placed four and one-quarter inches in from the end of the drum, support the upper part of the vial. The 20 vials accommodated by this arrangement are rotated mechanically about the axis of the drum.

The trough is provided with an inlet and outlet tube to provide constantly flowing cool tap water. The inlet tube is extended to the bottom and near the center back of the trough, while the outlet tube is located in the center and three-fourths inch from the top of the right end of the trough. The revolving drum is mounted horizontally, so that four and three-quarters inches of each of the discs are immersed under water. The constant flow of tap water below 20°C. is provided to keep the cuprammonium solution in the vials cool and below room temperature, thus facilitating the dispersion of cellulose in the solution.

The shaft of the drum is aligned with a Boston gear reducer (ratio 48) by means of a packing gland and flexible coupling. A one-sixth-horse-power-motor also is aligned with the gear reducer by means of a flexible coupling. This gears the drum in the trough to 35 revolutions per minute.

The trough, gear reducer, and motor are mounted on a wooden platform measuring 30¼ x 18 inches, thus making a compact movable unit.

A structural diagram of the mixing equipment is shown in Figure 2, and a pictorial illustration in Figure 3.

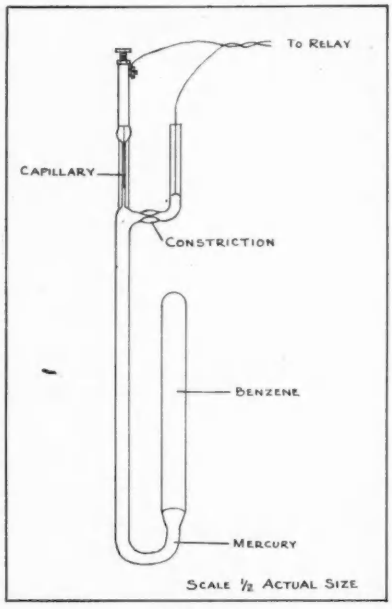


Figure 4

Thermo-Regulator for Constant Temperature Bath.

The use of this mixing apparatus to replace that devised by Stubblebine increases the number of fluidity determinations in one run from eight to 40, since two measurements in different viscometers can be made from the contents of each vial.

The Constant Temperature Bath

The constant temperature bath consists of a rectangular glass aquarium measuring 24 x 12 x 12 inches, with glass sides, and a masonite bottom. The seven chambers used to hold the viscometers are made of 48-millimeter glass tubing, 25 centimeters long. The lower ends of these tubes are mounted in the bottom of the bath by means of Number 11 rubber stoppers, which serve as gaskets. The upper ends are fitted into holes in a water-resistant wooden rack. The tubes are spaced three centimeters apart. A Number 10 rubber stopper with a hole drilled to accommodate the Number 4 stopper surrounding the pipette viscometer is cemented inside the lower end of each glass tube. A wedged Number 10 stopper is placed in the top of the tube to hold the viscometer in a vertical position.

A copper water-cooling coil is placed near the floor and at the back of the water bath. Below the water-coil a lo-lag heating circuit is introduced. This in turn is connected in series to a rheostat, a relay circuit, and a thermo-regulator. The relay circuit is constructed according to the mechanism described by Hersh, Fry, and Fenske (*2*). The thermo-regulator consists of an especially designed glass tube pictured in Figure 4.

The closed end of the tube is constricted at the elbow and filled with benzene. The column is then filled with mercury. The circuit of the regulator is completed by the adjustable needle contact wire regulated by a brass screw adjustment mounted on the top of the column, and a contact wire immersed in mercury in the upper side arm leading into the main column.

A motor mounted at the back of the bath and driving a metal-shafted fan of stainless steel, placed inside near the back of the water bath, provides good circulation of the water.

Back of the glass tubes which hold the viscometers, a light-weight stainless steel rack is introduced to accommodate the 20 glass mixing vials and a calibrated thermometer graduated in one-tenth degrees. The temperature of the bath is maintained at 20° ± 0.1° C. during measurements.

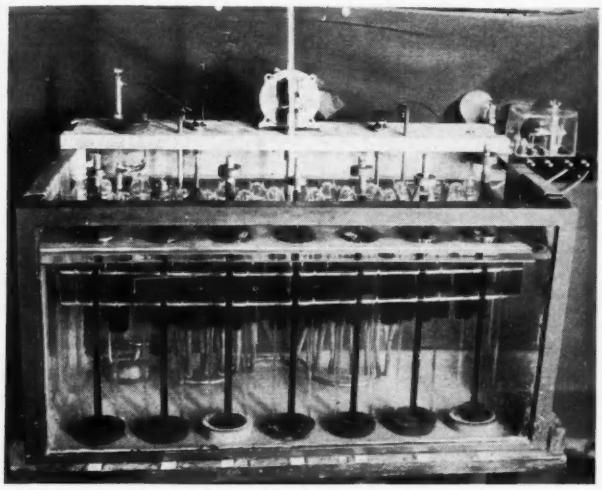


Figure 5
Constant Temperature Bath Adapted to Accommodate 20 Mixing Vials and Seven Pipette Viscometers.

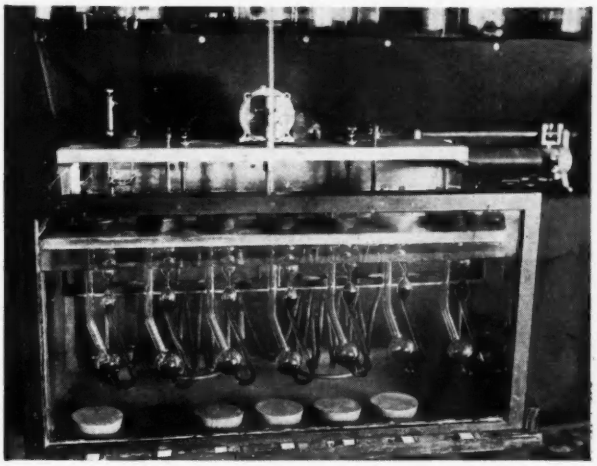


Figure 6
Constant Temperature Bath Adapted to Accommodate Seven Cannon-Fenske Viscometers.

A view of the water bath accommodating the 20 mixing vials and the seven pipette viscometers is shown in Figure 5.

To adapt the water bath for measurements made on cellulose acetate rayon in acetone, the glass tubes and stoppers in which they are inserted are removed and replaced with Number 12 rubber stoppers. The Cannon-Fenske viscometers are supported in the wooden rack by means of Number 11 rubber stoppers. An illustration of the water bath accommodating the seven Cannon-Fenske viscometers is shown in Figure 6.

Accessories for the Preparation of Samples for Fluidity Measurements

The desized air-dried specimens are ground in a Wiley mill (shown in Figure 7) to promote intimate contact between the sample and the solution.

To facilitate the weighing and transference of the finely ground materials, metal scoops of a size sufficient to hold 0.5 gram, 1.0 gram, and 2.0 grams of materials were made. The scoops are so shaped as to fit the mouth of the vials conveniently. Thus the sample can be brushed easily into the mixing vial by means of a camel's hair brush, or samples can be weighed in advance and the weighed sample transferred into a glass weighing bottle.

The scoops, funnel, vial, and calibrated stop watch are shown in Figure 8. The viscometer shown in this photograph is the Cannon-Fenske type used for measurements made on cellulose acetate rayon in acetone.

Viscometers

The pipette viscometer used only as an instrument of flow is shown in Figure 9.

A Cannon-Fenske viscometer suitable for cellulose acetate viscosity determinations is shown in Figure 10.

After reaching temperature equilibrium of 20° ± 0.1° C. for one hour, the contents of the vial are poured into a a calibrated viscometer at the same temperature; the capillary end of the viscometer is closed by a stopper made of rubber tubing plugged with a small solid glass rod. The stopper then is removed and the solution, controlled by the finger at the top opening of the vis-

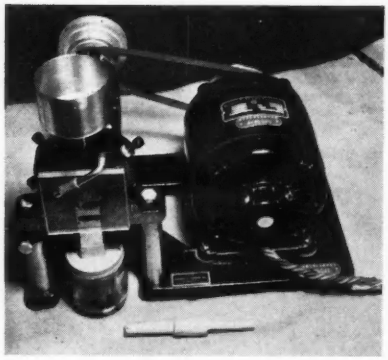


Figure 7
Wiley Mill Used for Preparation of Samples.

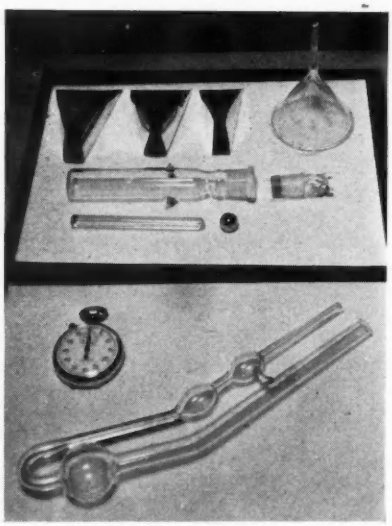


Figure 8
Accessories Used to Make Fluidity Measurements.

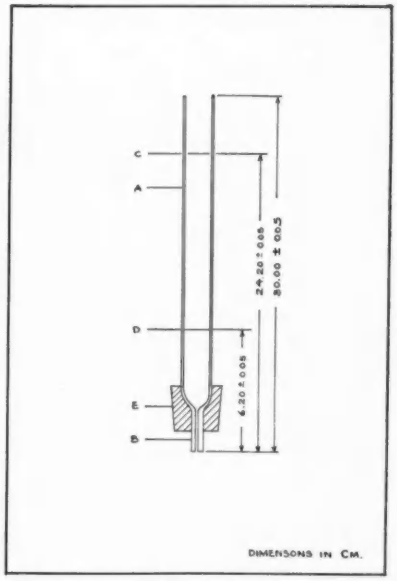


Figure 9
Diagram of Pipette Viscometer (A) Body of Viscometer; (B) Lower Capillary Tube; (C and D) Calibration Marks; (E) Rubber Stopper.

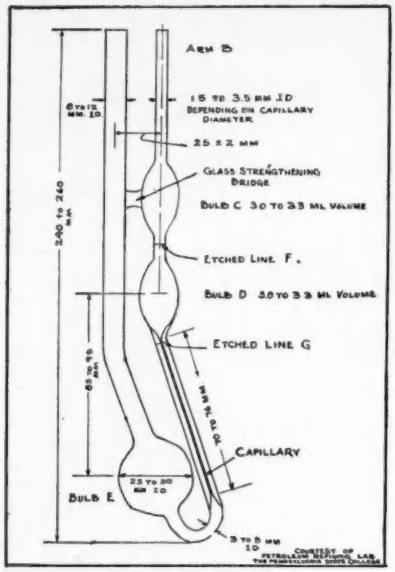

ARM B
1.5 TO 3.5 MM I.D. DEPENDING ON CAPILLARY DIAMETER
25 ± 2 MM
GLASS STRENGTHENING BRIDGE
BULB C 3.0 TO 3.3 ML VOLUME
ETCHED LINE F.
BULB D 3.0 TO 3.3 ML VOLUME
ETCHED LINE G
CAPILLARY
BULB E
240 TO 260 MM
65 TO 75 MM
23 TO 30 MM I.D.
3 TO 5 MM I.D.

Figure 10

Diagram of Cannon-Fenske Viscometer.

cometer, is brought to the upper calibration line. When drainage is completed so that the bottom of the meniscus coincides with the upper calibration mark, the finger is removed, and the time in seconds for the meniscus of the solution to fall from the upper to the lower calibration rings is measured. From the constants of the instruments used in the measurement, and the time of efflux, the fluidity is calculated by the Higgins (*1*) formula as given by Mease (*4*). Three glycerol and water solutions are used as calibration liquids. A slight simplification was introduced by the authors in that kinematic viscosity determinations are made on these solutions to simplify the calculations of the *A* and *B* constants. This eliminates the necessity for determining the density of solutions.

The viscometers are cleaned between measurements first with distilled water followed by 6N nitric acid, then distilled water followed by acetone. They then are air dried.

Measurements Made to Check Reproducibility of Results of Cellulose in Cuprammonium Solution

In order to be assured of the reproducibility of results, a 0.5 per cent. concentration of alpha-cellulose in each of the 24 vials was run, and measurements were made in the eight different viscometers. The measurements obtained served as a check of one vial or of one viscometer in comparison with another. The consistancy of results is shown in Tables I and II.

It may be assumed from these data on alpha-cellulose that fluidity measurements of the type covered in this report would check closely from vial to vial and from viscometer to viscometer.

Table III shows the conformity of results obtained when 2.0 per cent. dispersions of viscose rayon were measured in different pipette viscometers. Duplicate measurements were within ± 2 per cent of the mean.

In a similar manner, Table IV shows duplicability of results for 0.5 per cent. solutions of cellulose acetate rayon measured in the Cannon-Fenske viscometer. Duplicate measurements fell within ± 0.5 per cent. of the average.

TABLE I

FLUIDITY IN RHES OF ALPHA CELLULOSE MIXED IN TWENTY-FOUR DIFFERENT VIALS

Vial Number	*Fluidity in Rhes xxx*	*Deviation from Mean Average*
1*x*	X	X
2	13.5	+0.5
3	13.1	+0.1
4	13.4	+0.4
5	13.1	+0.1
6	12.9	—0.1
7	13.2	+0.2
8	12.8	—0.2
9	12.6	—0.4
10	13.0	0.0
11	13.3	+0.3
12	12.9	—0.1
13	12.8	—0.2
14	12.8	—0.2
15	13.3	+0.3
16	12.9	—0.1
17	13.0	0.0
18	12.9	—0.1
19	12.9	—0.1
20	13.0	0.0
21	12.6	—0.4
22	12.8	—0.2
23	13.2	+0.2
24	13.2	+0.2
Mean	13.0	

x Vial Broken.
xxx Represents an average of two or more measurements.

TABLE II

FLUIDITY OF ALPHA-CELLULOSE IN RHES MEASURED IN DIFFERENT VISCOMETERS

Viscometer Number	*Fluidity In Rhes*	*Deviation from Mean Average*
#2	13.6	+0.3
	13.0	—0.3
	13.4	+0.1
	13.6	+0.3
	13.0	—0.3
	13.4	+0.1
	13.3	0.0
Mean	13.3	X
#5	13.8	+0.4
	13.3	+0.1
	13.3	—0.1
	13.4	0.0
	13.3	—0.1
Mean	13.4	X
#6	13.3	+0.2
	13.1	0.0
	13.1	0.0
	12.9	—0.2
Mean	13.1	X
#8	13.1	0.0
	13.2	+0.1
	13.3	+0.2
	13.5	+0.4
	12.8	—0.3
	12.8	—0.3
	13.1	0.0
	13.1	0.0
Mean	13.1	X
#3	13.8	+0.4
	13.5	+0.1
	12.9	—0.5
	13.5	+0.1
	13.1	—0.4
	13.3	—0.1
Mean	13.4	X

TABLE II (*Continued*)

FLUIDITY OF ALPHA-CELLULOSE IN RHES MEASURED IN DIFFERENT VISCOMETERS

Viscometer Number	*Fluidity In Rhes*	*Deviation from Mean Average*
#4	12.0	—0.3
	12.3	0.0
	12.2	—0.1
	12.4	+0.1
	12.4	+0.1
Mean	12.3	X
#7	12.6	—0.1
	12.7	0.0
	12.9	+0.2
Mean	12.8	X
#9	12.4	—0.3
	12.8	+0.1
	12.6	—0.1
	12.6	—0.1
	12.6	—0.1
	13.0	+0.3
	12.8	+0.1
	12.6	—0.1
Mean	12.7	X

Summary

Viscometers Number	*Fluidity In Rhes*	*Deviation from Mean Average*
#2	13.3	+0.2
#3	13.4	+0.3
#5	13.4	+0.3
#6	13.1	0.0
#7	12.7	—0.4
#8	13.1	0.0
#9	12.8	—0.3
Mean	13.1	

Measurements within ± 3.0 per cent of average.

TABLE III

APPARENT FLUIDITY OF VISCOSE RAYON IN RHES MEASURED IN DIFFERENT VISCOMETERS
(2.0 Per Cent Solution in Cuprammonium)

Textile Fabric Number	*Paired Fluidity Results in Different Viscometers (Rhes)*	*Deviation from Mean Average (Rhes)*
1	11.7	—0.1
	11.8	0.0
2	16.6	0.0
	16.5	—0.1
3	10.4	—0.1
	10.6	+0.1
4	11.3	+0.1
	11.1	—0.1
5	12.5	+0.2
	12.0	—0.3
6	17.3	—0.1
	17.4	0.0
7	10.9	—0.2
	11.2	+0.2
8	13.2	+0.2
	12.8	—0.2

Measurements within ± 2.4 per cent of average.

TABLE IV

FLUIDITY OF CELLULOSE ACETATE RAYON IN RHES MEASURED IN DIFFERENT VISCOMETERS
(0.5 Per Cent Solution in Acetone)

Textile Fabric Number	*Paired Fluidity Results in Different Viscometers (Rhes)*	*Deviation from Mean Average (Rhes)*
1	168	—1
	170	+1
2	174	+1
	172	—1
3	167	+1
	165	—1
4	167	0
	167	0
5	164	—1
	165	0
6	172	0
	171	—1
7	166	0
	166	0
8	170	0
	170	0

Measurements within ± 0.6 per cent of average.

Summary

This report describes equipment and techniques for making measurements of fluidity both for cellulose in cuprammonium solution and for cellulose acetate in acetone. The equipment is not difficult of construction, and it permits an increased number of determinations to be made daily.

Acknowledgments

The authors are indebted to the American Viscose Corporation, who supported the Research Fellowship at The Pennsylvania State College, which made it possible for them to undertake this study.

Acknowledgement is also made to Dr. George H. Fleming of the School of Chemistry and Physics of The Pennsylvania State College for help and advice in planning and designing the mixing equipment and constant temperature bath.

The authors, moreover, are deeply grateful to Dr. Pauline Beery Mack, Director of the Ellen H. Richards Institute, The Pennsylvania State College, for her encouragement in the pursuit of this problem and the provision of the physical means for undertaking this investigation.

The mixing equipment was built by the Nittany Scientific Company, State College, Pennsylvania; the glass mixing vials by the Nittany Scientific Glass Company, State College, Pennsylvania.

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(3) Mease, R. T., *An Improvement in the Method for Dissolving Cellulose in Cuprammonium Solution for Fluidity Measurements,* National Bureau of Standards Research Paper R P 1442 (1941)

(4) Mease, R. T., *Measurement of the Apparent Fluidity of Dispersions of Cellulose in Cuprammonium Solution,* National Bureau of Standards Research Paper R P (1939)

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TRADE NOTES • NEW PRODUCTS

• Plans for Phi Psi Convention

The Charlotte Alumni Chapter of the Phi Psi Textile Fraternity is completing plans for the 21st National Convention to be held in Charlotte, N. C., May 2 and 3, 1947. An exhibit by each chapter of Phi-Psi from all the Textile Schools will be shown and prizes will be given, the first prize consisting of a Plaque donated by Pomona Manufacturing Company, Greensboro, N. C. and a $100 check donated by Walter Dillard, Executive Vice-President of Pomona Manufacturing Company. Members are urged to make reservations promptly at the Hotel Charlotte and in asking for reservations, state that they are coming to the Phi Psi Convention, as the hotel has set aside rooms for Phi Psi members. It is also requested that when possible two members occupy the same room, as a matter of cooperation with the hotel. Registration starts at noon on Friday, May 2nd, and following is the tentative schedule of events:

Friday, May 2nd—Registration.

Friday afternoon—Golf.

Friday, 5:00 to 7:00 P.M.—Open House.

Friday, 7:00 P.M.—Buffet Supper and Entertainment.

Saturday, May 3rd, 10:00 A.M.—Business Meeting.

Saturday, Noon—Grand Council Meeting.

Saturday, 2:00 to 4:00 P.M.—Inspection of Exhibits.

Saturday, 5:00 to 7:00 P.M.—Open House.

Saturday, 7:30 P.M.—Banquet and Entertainment.

Anyone desiring any additional information should contact Jack Killheffer, DuPont Company, Charlotte, N. C.

• Quaker Oats Promotions

Lauren B. Hitchcock has been appointed vice president in charge of the Chemicals Department of The Quaker Oats Company. Since 1944 Dr. Hitchcock has served as manager of the Chemicals Department in the development of furan chemicals. Formerly he was with Hooker Electrochemical Company, Niagara Falls, N. Y., as manager of sales development.

Fredus N. Peters, Jr., former director of research, has been appointed vice president in charge of chemical research. Dr. Peters has been in charge of nutritional and organic chemical research for many years and has made major contributions in the field of furan chemistry.

Frank F. McKinney was recently made sales manager of the Chemicals Department, to head technical sales of furan chemicals. After two and a half years service with the U. S. Army, Mr. McKinney returned in March of this year to his position with the Chemicals Department.

• Honored by Kiwanis

Luke J. Carbonetti, finisher for the Stonecutter Mills in Spindale, North Carolina has been voted by the Kiwanis Club of Rutherfordton as the most outstanding citizen of Rutherfordton for the past year.

Mr. Carbonetti has been active in Boy Scout work for the past three years, helped sponsor a recreational program last summer, supervised waste paper collections by the Scouts during the war, and helped in the Cancer and "Old Clothing" drives.

• New Technical Reports

Technical details of the processes and machines developed by I. G. Farbenindustrie for dyeing rayon cakes, hosiery and synthetic fabrics, together with formulas for many types of dyes and textile auxiliaries are contained in two reports now on sale by the Office of Technical Services, Department of Commerce.

The reports, which supplement earlier investigations in Germany, were prepared for Field Information Agency, Technical by consultants of the Office of the Quartermaster General. Rayon package and hosiery dyeing are summarized in a report by Thomas R. Smith, and dye formulas and process descriptions are contained in a report by C. Norris Rabold.

Orders for the reports (*Package Dyeing in Germany, Dyeing of Hosiery in Germany, Hotwater Heating of Dye Liquors;* PB-50759; microfilm, $1; photostat, $3; 43 pages; and *Observations on the Dyeing and Finishing Industry in Germany and Austria;* PB-50758; microfilm, $3; photostat, $8; 109 pages) should be addressed to the Office of Technical Ser-

vices, Department of Commerce, Washington 25, D. C., and should be accompanied by check or money order, payable to the Treasurer of the United States.

• Silk City Chemical Co.

Ernest Zillessen, Jr., has announced the formation of the Silk City Chemical Company with offices and warehouse located at 200 Carlisle Avenue, Paterson 1, New Jersey. The new company will handle a complete line of chemicals and dyestuffs for the textile industry. The 'phone number is ARmory 4-9540.

• Leeds & Northrup Head Honored

Charles S. Redding, president of Leeds & Northrup Company, manufacturers of electrical measuring instruments and heat treating furnaces, received the honorary degree of Doctor of Science at the midwinter commencement exercises of the University of Pennsylvania Feb. 15. The degree was presented by Dr. George William McClelland, president of the university, from which Mr. Redding was graduated in 1906 and subsequently served for two years as a member of the faculty. He is an associate trustee of the university. He succeeded Morris E. Leeds, now Chairman of the Board, as president of Leeds & Northrup Company in 1939.

• Commonwealth Chicago Office

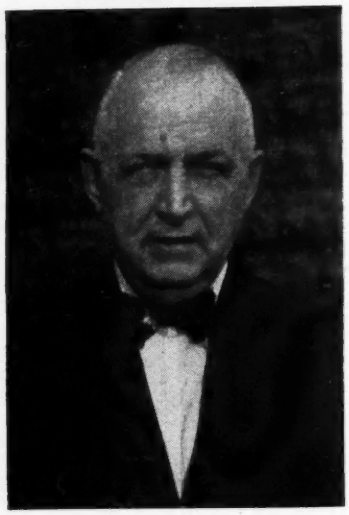
Commonwealth Color & Chemical Co. of Brooklyn, N. Y., announces the opening of their new Chicago Office at 442-450 North Wells Street. At this address greatly enlarged storage, laboratory and office facilities are available to better serve the firm's customers in the Middle West. An "open house" was held recently to celebrate this occasion.

• Nylon Research Supervisor

The Du Pont Company has announced the promotion of Dr. John H. Blomquist to the position of research supervisor in the nylon section of the Rayon Technical Division at Wilmington.

A native of Mankato, Minn., Dr. Blomquist, who is 31 years of age, is a graduate of Washington High School, Cedar Rapids, Iowa. He was graduated from Coe College in 1937 with the degree of bachelor of arts in chemistry. While studying at Ohio State University, where he was awarded the degrees of master of science and doctor of philosophy, the latter in 1941, Dr. Blomquist was a teaching assistant for three years. In 1940-41 he did research work in colloid chemistry on a university fellowship.

• Technical Director, American Aniline Southern Division



Robert H. Nuttall, formerly Director of Application Laboratories at the Lock Haven Plant of the American Aniline Products, Inc., who has been advanced to the post of Technical Director of the Company's Southern operations.

In his new post Mr. Nuttall will coordinate and direct all phases of both laboratory work and demonstrations for the Charlotte and Chattanooga Branches.

Mr. Nuttall is well known to the southern mills having formerly been Superintendent of Printing at Lanett Bleachery and Pacific Mills and his return to this territory will enable him to renew many old friendships.

• Divisional Heads, American Viscose

Jackson A. Woodruff and Harry F. Creegan have been appointed divisional heads of the Textile Research Department, American Viscose Corporation, Marcus Hook, Pa., it is announced by the company.

Mr. Woodruff, formerly in charge of the laboratory for research in dyeing and finishing has been named head of the department's Textile Development Laboratories. This division will be active in the application of research on dyeing and finishing materials and methods and will provide various testing facilities for the company's Textile Research Department.

Mr. Creegan, who joined the department in 1942 and was formerly assistant head of the Dyeing and Finishing Division, has been appointed head of the division. He replaces James A. Hopwood, who is now associated with Colonial Mills, Clarksville, Va.

• Stein, Hall Officers

Stein, Hall & Company, Inc., importers and manufacturers of industrial raw materials with headquarters at 285 Madison Ave., New York City, announce the following list of officers and directors, who were elected at the Company's Annual Meeting:

Chairman of the Board: Arthur L. Strasser.

President and Director: Edwin Stein.

Executive Vice President and Director: Morris S. Rosenthal.

Treasurer, Secretary and Director: Robert Rau.

Vice Presidents and Directors: Oliver H. Clapp, Cecil H. Coryat, Robert M. Stein, Robert Strasser.

Vice Presidents: J. Rex Adams, J. Chesman Daly, Lawrence Gussman, Andre L. Picard.

Assistant Vice Presidents: George W. Brew, Donald V. Brandon, C. J. Dunachie, Miss Sadie Feldman, S. Hochberger, H. M. Johnston, W. W. Strasser, Jr., L. F. Turnbull.

Assistant Tresaurer: Alexander M. Dorenus.

Assistant Secretary: Hannah L. O'Neill.

Auditor: Joseph M. Horine.

• Golden Anniversary, LTI

The Golden Anniversary Reunion of the Lowell Textile Institute, Lowell, Massachusetts, will be held on Friday, April 25th and Saturday, April 26th.

On Friday there will be a banquet at the Hotel Statler in Boston with a prominent speaker and some entertainment.

Saturday will be Open House at the Lowell Textile Institute in Lowell with Inspection of Building Plans for the new Dormitory, a Buffet Luncheon, Business Meeting, Laying of the Cornerstone for the new Dormitory, Unveiling the Portrait of President Emeritus Charles H. Eames, and an opportunity to study the proposed new Library plans.

Harold V. Farnsworth ('16) is Chairman of the Committee on Arrangements and James A. Irving ('17) is Assistant Chairman.

• Durfee Company Moves Offices and Laboratories

W. C. Durfee Co., Inc., have announced that their offices and laboratories are now located and combined with their plant at 463-7 Commercial Street, Boston 13, Mass. Phone numbers are: CAPitol 9240-1-2-3.

• Tergolene No. 47

De Paul Chemical Company, Inc., 44-27 Purvis Street, Long Island City 1, New York, has announced Tergolene No. 47, a non-volatile dispersing agent for acetate colors. It is intended for use in place of the usual solvents or solvent and glycols used in connection with the dispersion or dissolving of such acetate colors before dyeing or printing.

The material is available in quantities and, it is claimed, will show a saving per unit yardage as very much less is required to maintain the color dispersed and uniformly distributed in the processing. It is stated that there is no evaporation, odor or fire hazard.

• Harris Research Laboratories and Harris Instruments

Milton Harris Associates announces a change in name to Harris Research Laboratories and the formation of a new organization, Harris Instruments, Inc.

Harris Research Laboratories will be staffed by the personnel of the present organization, which consists of 30 chemists, physicists, engineers, etc., and will continue its same program of research, development, and consultation for the textile and allied industries.

Harris Instruments, Inc. will conduct instrumentation research and develop and manufacture new research instruments, especially for the textile industry.

• Sizing Conferences

The Textile Research Institute announces a series of scientific round-table conferences on textile sizing, which it is co-sponsoring this spring with leading textile schools.

The first of the series was held in Philadelphia the evening of March 7th, in co-sponsorship with the Philadelphia Textile Institute. Dean Richard S. Cox, of the Philadelphia school was host.

The purpose of the conferences is to pool existing knowledge on sizing and to develope, through discussion, sound principles, the objectives of future research and the qualities to be sought in sizes for various yarns and fabrics. Scientists and production men from all branches of the textile industry are being invited to attend.

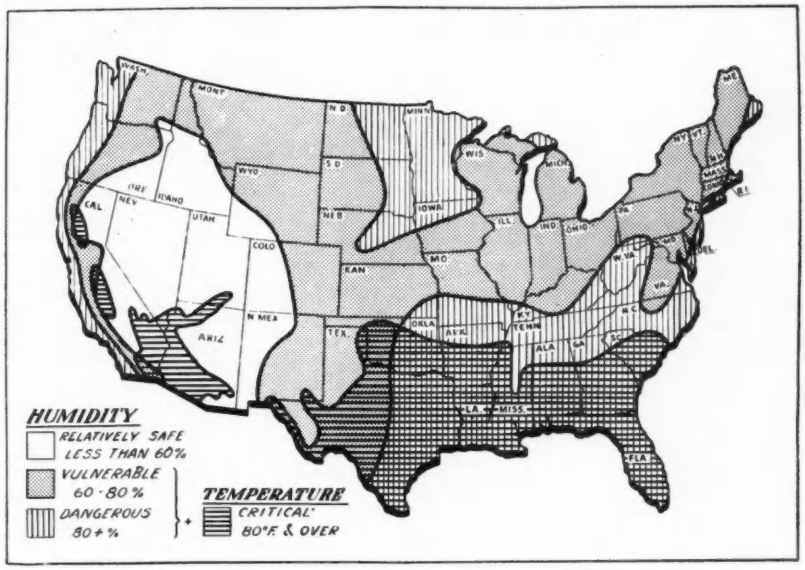
On March 21st, the second of the series will be held in New York City at the Biltmore Hotel, solely sponsored by the Textile Research Institute. A sponsoring committee will have charge and is composed of A. G. Ashcroft, Alexander Smith & Sons Carpet Company; Werner von Bergen, Forstmann Woolen Mills; Dr. John H. Dillon, Textile Research Institute; Richard T. Kropf, Belding-Heminway-Corticelli; J. B. Goldberg, J. P. Stevens & Company; and Fred Noechel, Botany Worsted Mills. This meeting will be held during the day for those invited from the textile centers of northern New Jersey, lower New York, and Connecticut.

The third conference will be held in Boston on March 28th. This New England meeting is being co-sponsored by the Lowell Textile Institute, the Textile Division of Massachusetts Institute of Technology and the Textile Research Institute. Both Kenneth Fox, President of Lowell Textile Institute, and Professor E. R. Schwarz, of Massachusetts Institute of Technology, will participate actively during this evening session at the Hotel Statler. The conference will be preceded by dinner at 6:30 p.m.

Attendance at these conferences is by invitation of those in the textile industry primarily concerned with sizing. It is felt by this limitation that those attending may all contribute to the discussions and in turn benefit to the greatest possible extent in free exchange of knowledge.

The last of the conference series for this spring will be held in Charlotte, North Carolina, on May 2nd. Both the Clemson Agricultural College and North Carolina State College, schools of textiles are participating in the co-sponsorship, with Dean Hugh M. Brown of the latter and Dean Malcolm E. Campbell of the former taking active part in the proposed

• Areas Vulnerable to Mildew Attack



Mildew and rot, generally believed to be a problem only in the semi-tropical areas of the South, actually attack textile, paper, and other vulnerable materials throughout the United States, doing great damage in 75 per cent of the nation, and costing the American public, by conservative estimate, more than 100 million dollars annually. This map, prepared by Givaudan-Delawanna, Inc., a chemical firm which has done extensive mildew and mildew-proofing research, shows those areas of the United States which are vulnerable to attacks during an average July. It also helps explain the growing interest in fungicidal finishes among manufacturers.

Humidity, not temperature, is the key factor in the fungi problem. Temperature can range as low as 45 degrees F. and still invite fungi destruction as long as the humidity is 75 per cent or more. The Vertical lines on the map mark areas where the humidity exceeds 80 per cent (dangerous), the dotted areas where it ranges from 60 to 80 per cent (vulnerable), and the white areas where it is less than 60 per cent (relatively safe). The horizontal lines indicate the critical areas where high humidity combines with temperature exceeding 80 degrees F.

day's program. This conference will be at the Hotel Barringer in Charlotte where arrangements have been completed to start at 10:30 a.m. with time reserved for lunch.

Following each of the conferences a consolidated report embodying the information developed at all the conferences will be furnished each person attending any single conference.

• Appointed Editor, Colourists Journal

C. L. Bird, M.Sc., F.R.I.C., has been appointed Editor of the *Journal of the Society of Dyers and Colourists* in succession to the late Professor F. W. Rowe, D.Sc., F.R.I.C., F.R.S.

Mr. Bird, who was previously the Assistant Editor of the Journal, is Lecturer in Dyeing at Leeds University and the author of a textbook entitled "The Theory and Practice of Wool Dyeing" which is about to be published by the Society.

• To Produce New Vinyl Yarn

A new versatile vinyl yarn that shows promise in a practically unlimited number of textile applications will soon be available in semicommercial quantities from Carbide and Carbon Chemicals Corporation. The new yarn is said to have dimensional stability in boiling water and can be readily dyed dark and brilliant shades with a wide range of the usual synthetic fiber colors. It also has the high strength and good resistance to chemical attack that are characteristic of vinyl yarns now in commercial production. Like them, it will not support combustion, is water resistant, and is completely unaffected by microorganisms and insects.

Marketed as "Vinyon" yarn, type N, the new material is basically different from other vinyl materials. It is produced from a white, powdery resin that results from the copolymerization of vinyl chloride and acrylonitrile. This resin is dissolved in acetone and spun on equipment similar to that in general use for making acetate rayon. Both the resin and finished yarn will be available in limited quantities this summer from development units now under construction at the South Charleston, West Virginia, plant of Carbide and Carbon Chemicals Corporation.

Dimensional stability is an outstanding property of the new yarn. Immersion in boiling water is said to produce a shrinkage of less than 0.5 per cent, and exposure to steam at 250 deg. F. results in a shrinkage of only about 6 per cent

It is stated that its ultimate tensile strengths range from 3.5 to 4.0 grams per denier, wet or dry, and it has an ultimate extensibility of 12 to 30 per cent. There will be several different types of yarn offering various combinations of properties, depending upon the end-use intended.

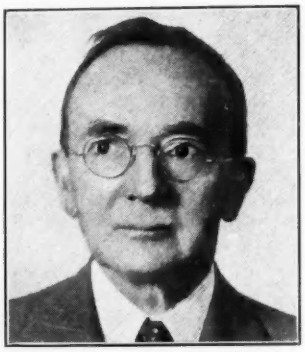
The present natural color of "Vinyon" yarn, type N, is a light gold and it is expected that a completely white yarn will soon be produced. It is stated that the present yarn can be dyed successfully by regular commercial processes using a wide range of acetate and vat dyestuffs, and it can be readily bleached by the ordinary commercial methods. Dyeing can be done at the usual temperatures, but deeper shades and virtually complete penetration result from dyeing at a boil. Tests on dyed materials are said to indicate them to be quite crock-fast and fast to washing.

It is claimed that materials made with this new "Vinyon" brand yarn will neither mildew nor support bacteria, molds, or fungi of any kind and are not attacked by insects, including carpet beetles. They have good electrical insulating properties, are unaffected by perspiration, and extensive exposure tests show no indications of allergic reactions. In addition, they are said to be resistant to most common solvents and chemicals except under the most severe conditions, such as for example cyclohexanone at high temperatures.

It is stated that, in view of the widespread interest in measures to protect the public against fire hazards, the flame resistance of fabrics made with "Vinyon" yarn, type N, is especially noteworthy. A further advantage is that these fabrics can be dry-cleaned without ill effects.

Because of its properties, this yarn is readily adapted to new textile applications. Fabrics based on the new yarn, unlike the majority of synthetics, are said to feel warm to the touch and have a "hand" surprisingly similar to silk. These characteristics are expected to prove advantageous in foundation garments, dress goods, and bathing suits. Full-fashioned hosiery of the new fiber is still in the experimental stage, and results indicate that satisfactory colors and resistance to dis-

• Dr. M. L. Crossley Awarded Gold Medal



Dr. M. L. Crossley, director of research, Calco Chemical Division, of the American Cyanamid Company, who has been unanimously selected to receive the 1947 gold medal of the American Institute of Chemistry.

Dr. Foster Dee Snell, president of the Institute, stated that the award is made in recognition not only of Dr. Crossley's scientific work and leadership in research leading to discoveries in the fields of dyes and pharmaceuticals, but also of his activities in behalf of the profession of chemists.

The medal of the Institute is awarded annually for "noteworthy and outstanding service to the science of chemistry or the profession of chemists in America." Previous recipients of this honor included: Willard H. Dow, president of Dow Chemical Company; George Eastman, of Eastman Kodak Company; and James B. Conant, president of Harvard University.

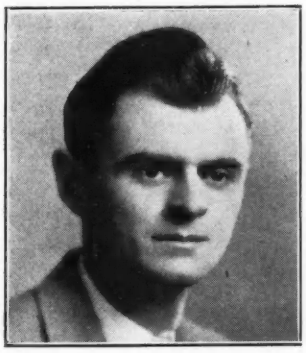
Dr. Crossley was born in Saba Island, Dutch West Indies. He studied at Brown University, Rhode Island, which conferred on him in course the degrees of Ph.B., Sc.M., Ph.D., and in 1944 awarded him the honorary Sc.D.

From 1914 to 1918, Dr. Crossley was head of the department of chemistry at Wesleyan University, Middletown, Connecticut. He joined the Calco Chemical Company in 1918 as chief chemist, and in 1938 was named director of research. When the company became the Calco Chemical Division of the American Cyanamid Company in 1939, Dr. Crossley was named director of research, and in 1941 appointed a director of research of the American Cyanamid Company.

Dr. Crossley has had a leading part in research on the relation of molecular structure to color in organic compounds; in the synthesis of dyes; in the discovery and industrial development of the sulfa drugs and in a fundamental study of the chemistry of infectious diseases, especially the changes in certain constituents of the blood in pneumonia and in the chemotherapy of cancer.

Presentation of the medal will be made at the Annual Meeting of the Institute to be held in May.

• Joins Heyden Chemical



Vincent R. Rebak, who has joined the New York Sales organization of Heyden Chemical Corp., 393 Seventh Ave., New York. Mr. Rebak is a graduate of St. John's University and spent four years with the AAF during World War II. Prior to joining Heyden he was with the New York Sales Division of Miles Laboratories, Inc. He will service Heyden accounts in upper New York State as well as Cleveland and Akron, Ohio.

tortion and retention of shape are obtained. Rain and sportswear, in addition to a wide variety of industrial materials such as filter fabric and sewing thread, have shown unusually promising results.

Because of the strength and abrasion resistance of this material, as well as its resistance to mildew and insects, it holds promise for nettings, draperies, rugs, and upholstery fabrics. Other applications which appear successful include fireproof materials, fishing lines, and narrow fabrics.

Only small amounts of the yarn are being made at present from laboratory facilities, but when the production units are operating, considerably larger amounts of yarn will be spun in standard deniers from 35 to the heaviest counts required for industrial uses. Distribution of the yarn for test and small-scale fabrication will be handled by the company's New York office.

• Cook-P & N Machine Company

Announcement has been made of the formation of the Cook-P & N Machine Co., Inc., an affiliation of the former Cook Machine Co. of Waltham, Mass. and Peterson and Neville, Inc. of Boston, Mass.

The company will offer the textile trade a broadened line of finishing machinery. The company states that both its increased manufacturing facilities and the experience of its founders will center on more economical and effective adaptation of its equipment to individual mill needs. The company is the sole licensee for the Cook patented machines and its finishing equipment, designed for the most effective use of stainless steel, will include: steam agers, padders of all types, dye becks, dye kettles, squeezers, rope soapers and washers, slack washers, tight rope washers, continuous bleach ranges, cloth opening ranges, stretchers, scutchers, "P" boxes, and similar equipment.

President of the company is George A. Parsons who is also vice-president of Peterson and Neville, Inc., and a former vice-president of the C. L. Stevens Co., industrial engineers. Vice-president and general sales manager is Percy Cook, formerly sole owner of Cook Machine Co. He is the inventor of the Cook Patented Detwister and also of the Automatic Detacking Machine.

The main office and manufacturing facilities are located at 367 Dorchester Avenue, Boston 27, Mass.

• Synthetic Rubber Adhesive

A new synthetic rubber adhesive has been developed by United States Rubber Company for use in conjunction with textile fibers to make plush, velour, suede and velvet surfaces.

The adhesive is said to have longer life and more flexibility than base coat enamel adhesives now being used. It can be dyed any color to match the textile fibers.

The product is called flocking adhesive M-6177. It may be sprayed or brushed on wood, metal, glass and other surfaces. It is intended for use with tiny strands of rayon, cotton, or wool known as flock. The strands range from 1/32 to ⅛ inches in length, depending upon the depth of pile desired.

• Wool Dyeing Data

Another folder in the series of Technical Service Data which is supplied to those interested in a particular processing problem has been issued by the Textile Chemical Division of the Dexter Chemical Corporation of New York City.

This folder is concerned with the problem of the level dyeing of wool and the deterioration of the handle and strength of the stock resulting from the removal of the natural grease content.

It presents, in this connection, "Maxitol No. 10" and its use as a protective agent and dyeing oil. It is claimed that this highly sulfated oil not only promotes level dyeing of wool and assists in penetration but also protects the fibers both in dyeing and bleaching and in after use.

The data sheets bound in this folder include the customary information regarding the properties and reaction of the processing agent (Maxitol No. 10), its uses, the formulae for its various uses and the chemical methods for its analysis.

Textile plant executives interested in this particular problem may obtain a copy of this folder by writing the Dexter Chemical Corporation (Textile Chemical Division), 819 Edgewater Road, New York 59, N. Y.

• Joins Sun Chemical

Wilbur A. Young has been appointed Service and Sales Engineer for the Metallic Soap Department of Warwick Chemical Co., Div. Sun Chemical Corporation. Mr. Young was formerly Plant Manager for M. W. Parsons Company of New York.

• Organic Chlorine Compounds

A new booklet, "Organic Chlorine Compounds," presenting the latest data on twelve chlorinated compounds, industrially important as solvents, fumigants, and chemical intermediates, has just been published by Carbide and Carbon Chemicals Corporation. It is one of a series of publications on the various groups of aliphatic organic chemicals. Information is given on the properties and uses, specifications, solubilities, comparative stability to reducing and oxidizing agents, and constant boiling mixtures. The booklet also contains charts showing the variation of certain properties with respect to temperature. A comprehensive bibliography is also included. This publication will prove a useful reference source for research chemists, laboratory technicians, and purchasing agents. Copies may be obtained by writing to Carbide nad Carbon Chemicals Corporation, 30 East 42nd Street, New York 17, N. Y. and asking for Form 4769.

• Joins Greenwood Mills

Marvin R. Cross, President, has announced that Joseph F. Merten has joined Greenwood Mills, Inc. He will be primarily identified with the Rayon Department and his work will be principally that of "Quality Control."

Mr. Merten is well known in the trade, and has had wide experience in the line of work he will follow. His previous connections have been with Burlington Mills and Verney Fabrics.

ABSTRACTS FROM CONTEMPORARY JOURNALS

Selection of Dyestuffs for Compound Shades

K. E. Scott, The Textile Manufacturer, page 176, Vol. 72, No. 856, April, 1946.

Fastness requirements are usually more important than exact matching in compound shades. Dyestuffs should be chosen which have an equal dyeing rate keeping in mind that in combining two dyestuffs their dyeing rates and fastness properties may be greatly altered from what they were if used alone. In general the best results are obtained by using dyestuffs from identical groups. A new recipe should be tested carefully before using it on a commercial run. The following test is recommended as a type which has been found suitable for general work:—

"A strip of cloth is dyed with the recipe, washed off, and dried in the normal manner. It is then cut into six equal sized pieces. The six pieces are introduced into the testing solution and treated for 10 min. One piece is then removed and the treatment continued. After a further 10 min. another piece is removed from the solution. This process is repeated with all six pieces."

A stripping test produced over a period of one hour is thus obtained which will yield varying information.

The Manufacturer and Dyer as Partners in the Textile Industry

H. W. Partridge, The Textile Manufacturer, page 209, Vol. 72, No. 856, April, 1946.

A great deal of dyeing is carried out by commission dyers and not by actual manufacturers. Full cooperation between the dyer and manufacturer is essential for best results. There are many ways in which the manufacturer can assist the dyer and a number of examples are given. By smoothing the path of the dyer or helping him to avoid pitfalls, the manufacturer is working to his own ultimate advantages. He will obtain speedier service and the goods will be in better condition and of improved quality, with fewer seconds.

In like manner the dyer can be of invaluable assistance to the manufacturer. The dyer naturally has a wider knowledge of the technical properties of fibers, dyes and finishes and can act as a scientific and technical adviser to the manufacturer. This will ultimately act to the dyers' advantage. A number of ways in which the dyer can be of assistance to the manufacturer are also given.

Annual Meeting

The Journal of the Society of Dyers and Colourists, page 161, Vol. 62, No. 6, June, 1946.

The 62nd annual meeting of the Society of Dyers and Colourists was held on March 29, 1946. A number of items presented at this meeting will undoubtedly be of interest to the members of the AATCC.

The membership of the Society increased by 200 in 1945 over the previous year. In collaboration with the AATCC substantial progress on the work of the new *Colour Index* is reported. It is anticipated that it will be some time before the new index is ready and to cover this gap photolithographic copies of the old index are being prepared. The work of the Fastness Tests Committee has made satisfactory progress and certain sections of its work are now within sight of completion. Restrictions on paper did not permit the publication of all available matter in the Journal and the Society found it necessary to establish a waiting list for new subscribers. The treasurer reported a surplus for the year of £538.

Dr. C. J. T. Cronshaw retired as President and C. M. Whittaker was elected the new President.

The Dichroic Behavior of Substantive Dyes: Molecular Theory of the Dyeing of Cellulose.

T. H. Morton, Journal of the Society of Dyers and Colourists, page 272, Vol. 62, No. 9, September, 1946.

This paper is summarized as follows:

The observations of Ambronn on the dichroic behavior of cellulose fibers dyed with certain direct dyes have been extended. It is found that all direct dyes, all vat dyes in the reduced leuco-form, some insoluble azo dyes, and some acid dyes on ramie exhibit positive dichroism.

Elongated direct dye micelles and dye crystals exhibit negative dichroism.

These dichroic phenomena are best explained by the absorption of dye by cellulose as single molecules, not as micelles. In the dyed material the elongated direct dye molecules are oriented parallel to the cellulose molecular chains with which they are co-ordinately combined. Direct dye molecules are positioned transversely across elongated dye micelles.

These conclusions are confirmed by the dichroic behavior of ramie dyed with alcoholic solutions of direct dyes, in which it is believed the dyes are molecularly dispersed.

Normal, fully oxidized, vat dyed materials are not appreciably dichroic.

A molecular theory of the dyeing of cellulose with substantive dyes is described. The dye solution is considered to contain particles of all sizes from molecules to large aggregates in a state of dynamic equilibrium. Cellulose is capable, for mechanical reasons, of absorbing molecules and small aggregates only.

Further, the diffusion of dye molecules through the capillary pore system of cellulose is probably not a free diffusion, but a thermally activated process. The effect of these two factors can be combined into a "mobility factor" representing the retardation of diffusion from the speed expected for a free diffusion with absorption. The value of the mobility factor covers the range, 10^{-1} to 10^{-4}, for the direct dye class.

Dye absorption proceeds by means of the diffusion of dye molecules, which are continually reformed from the larger particles in dye solution, to the interior of the cellulose fiber, until finally a true equilibrium between dyed cellulose and dye solution is reached.

The essential conditions necessary for substantivity of dyes on cellulose are discussed.

Solvent Extraction of Cotton Wax

James H. Kettering, Charles F. Goldthwait and Rita M. Kraemer, Textile Research Journal, page 627, Vol. XVI, No. 12, December, 1946.

Different solvents extracted widely different amounts of waxy materials in experiments where quantity of solvent and sample, rate and total time of extraction, and other laboratory conditions were held constant. The Conrad technique using either ether or isopropyl alcohol was more efficient than any other technique tried for extraction of waxy materials from cotton. Trichlorethylene is an unsuitable solvent for use in cotton-wax determinations. A 6-hour extraction period was found to be adequate for comparative purposes. Ethyl alcohol, chloroform, carbon tetrachloride and benzene, in the order named, were increasingly harmful to cotton cloth in a 100-hour extraction experiment. However, since these solvents produced only slight degradation on the extracted fabrics, even in that length of time, all of them may be safely used in Soxhlet extraction of cotton fiber, yarn or fabric.

SANDOZ PRESENTS *The color achievement of the month*

Windblown Ivory BY BOTANY

A dress that quickens the imagination . . . a fabric that promises year-'round assurance of style-rightness . . . a color that brings beauty to any setting. Here is a dress with confident charm . . . in "Botany" Brand Flannel.

Such delicate colors as this ivory tone call for scrupulous attention in dyeing, and the use of dyes that are sure-handling and steadfast. Sandoz Chemical Works is proud that Botany Worsted Mills — famous for quality products — finds, in Sandoz colors, the dependability it insists upon.

At Sandoz, these two objectives — dyes that will give the manufacturer full efficiency in handling, dyes that will give the ultimate user the satisfaction of long-lasting beauty — direct the efforts of our research department. Prominent among Sandoz developments are ALIZARINE LIGHT BLUE 4GL, proven by mill use to be the outstanding Acid Blue for perfect level dyeing results and excellent fastness to light . . . and AZO RUBINOLE 3GP, XYLENE FAST YELLOW 2GP, ALIZARINE LIGHT VIOLET 2RC, which with ALIZARINE LIGHT BLUE 4GL, give improved resistance to water spotting and perspiration.

For acid, chrome or direct dyes . . . or auxiliary chemicals . . . for both natural and synthetic fibres . . . be guided by the successful "color achievements" you have been seeing in these Sandoz advertisements.

Sandoz application laboratories are located in New York, Boston, Philadelphia, Charlotte, Los Angeles, and Toronto, where stocks are carried. Other branches are in Chicago, Paterson and Providence.

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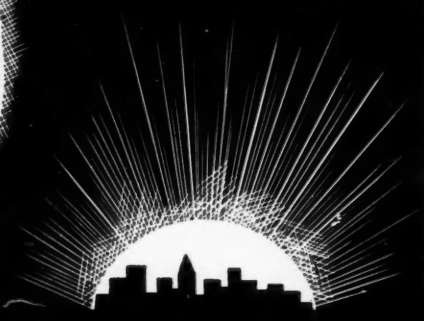
SANDOZ *thinks ahead with textiles*

SANDOZ

THE DAWN OF NEW FIBRES

. . . from Simple Fibres of Colonial Days to Nylon



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Logwood shows its versatility in the dyeing field by being able to dye Nylon the beautiful shade of black so desired by the silk trade. Nylon dyed with Logwood shows absolutely no fibre degradation.
Despite the many modern developments in dyestuffs, Logwood is still acknowledged the best for full-lustre, fast blacks. Full information as to formula used may be obtained by writing us.

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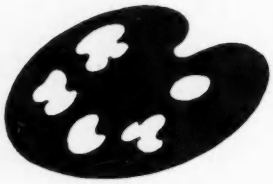

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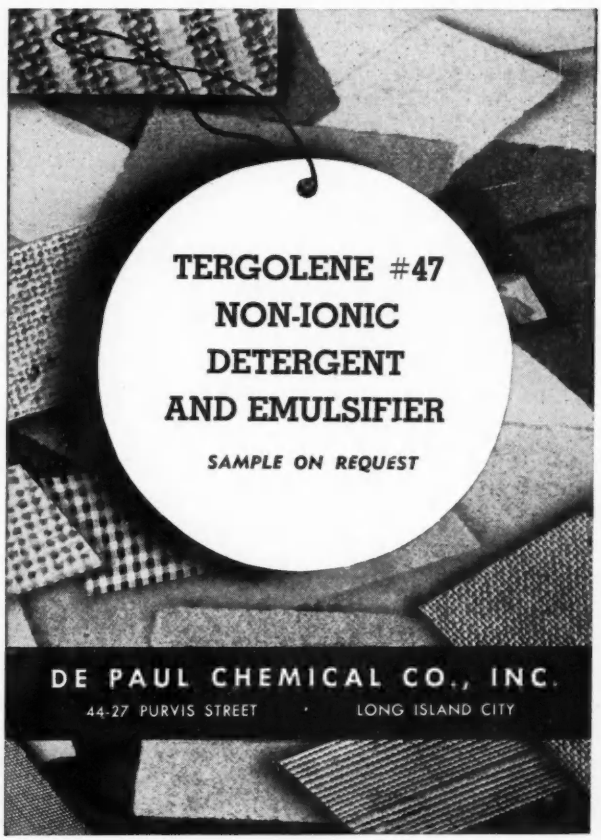

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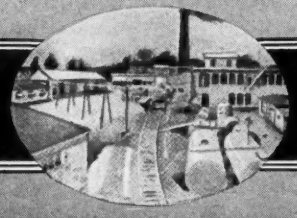

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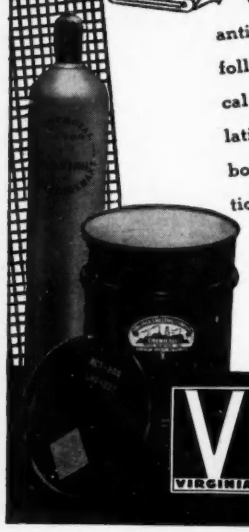

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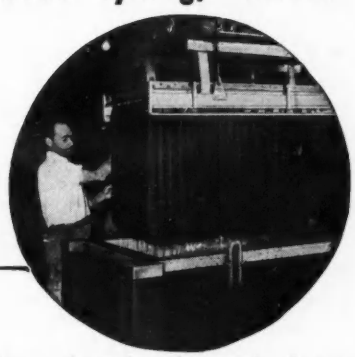

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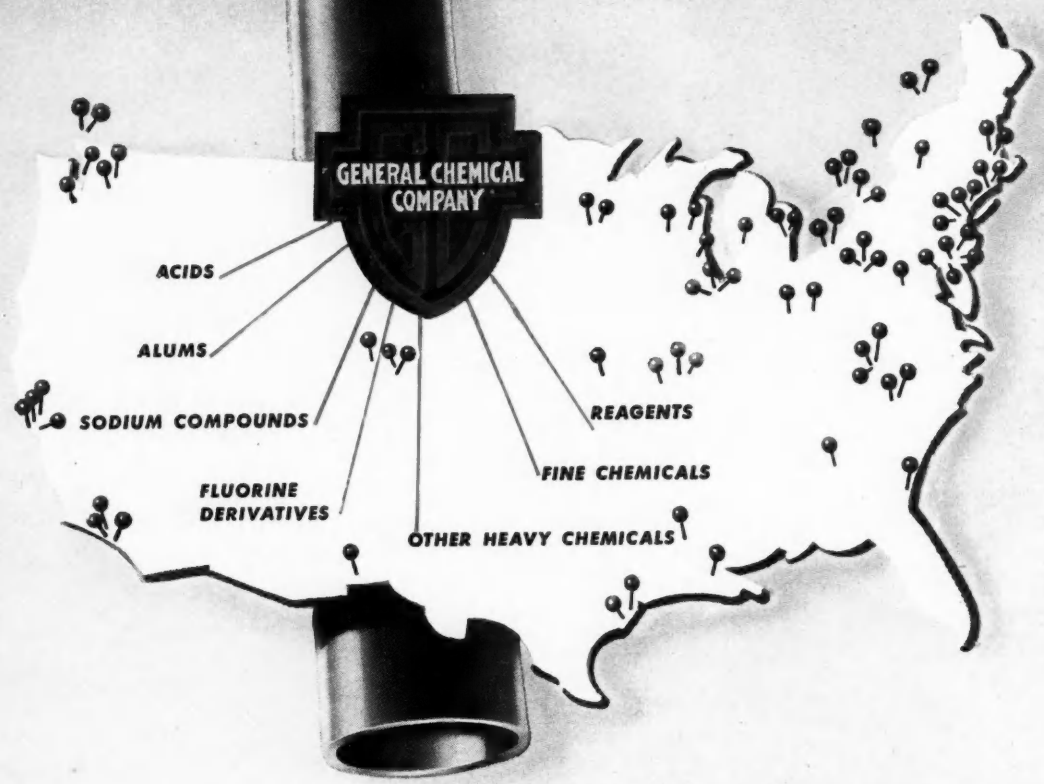

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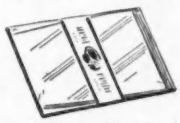
— to give your stockings *memory*

Stockings that look "handled" stay on the hosiery counter until all the "fresh" stockings are sold.



Stockings finished with Filaseal sell faster . . . stay smooth and fresh . . . resist snags and pulls.

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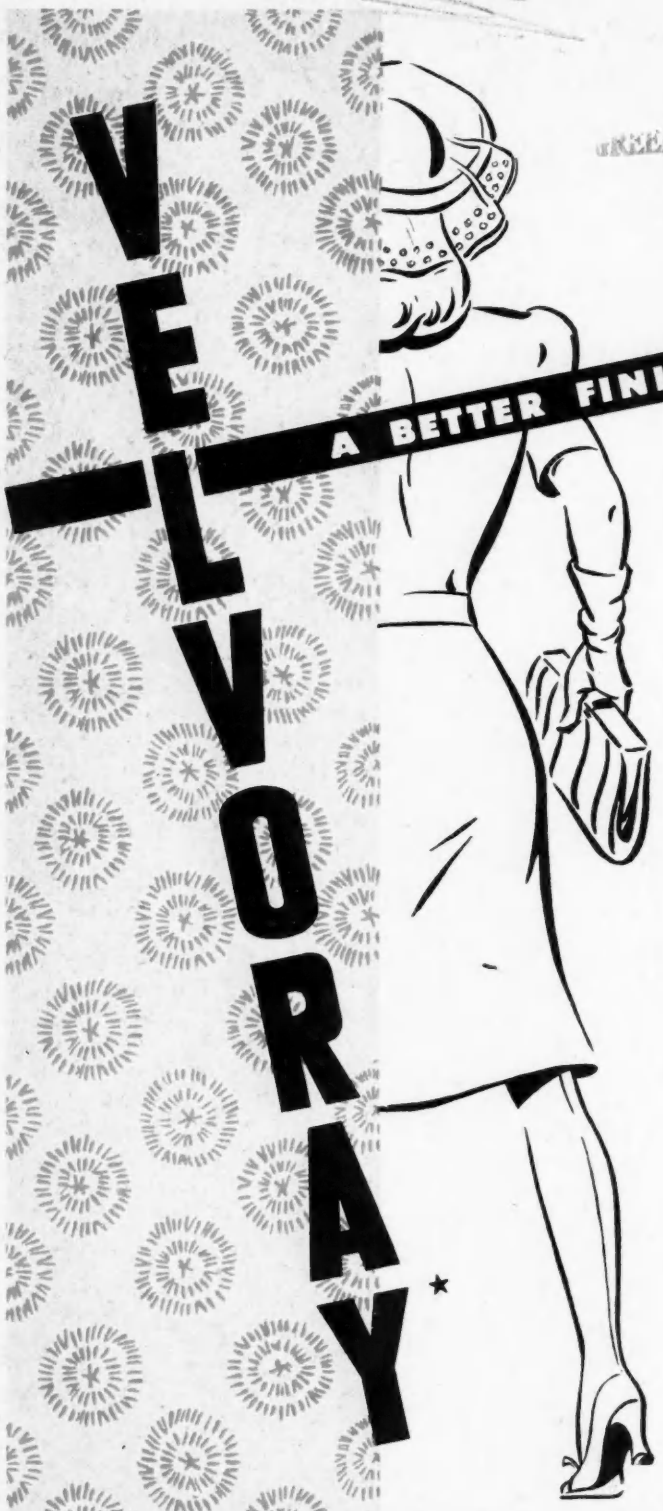
VELVORAY

A BETTER FINISHING OIL...



For soft, "bodying" effects—
for a quality feel that adds appeal—
use Velvoray as your finishing oil.

VELVORAY DOES NOT FOAM . . . produces regular results.

DOES NOT SMOKE . . . Velvoray goes into the goods, not up in smoke—economical!

DOES NOT OXIDIZE . . . Won't turn rancid . . . won't discolor fabrics.

STABLE EMULSION . . . No oil or fat globules form—a frequent cause of spotted fabrics.

Remember these two important points: Velvoray is a *better* finishing oil. It's made *only* by Royce.

made only by ROYCE

ROYCE CHEMICAL CO.

CARLTON HILL, NEW JERSEY

MANUFACTURERS OF NEOZYME* · PAROLITE* · DISCOLITE* · DRYTEX*
FABRITEX* · GUMOLITE · CASTROLITE* · VATROLITE* · ZIPOLITE*

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* Reg. Trade Mark

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